CHEMICAL & METALLURGICAL ENGINEERING

VOLUME 41 ESTABLISHED 1902 NUMBER 6

McGRAW-HILL PUBLISHING COMPANY, INC.

S. D. KIRKPATRICK, Editor

•

JUNE, 1934

•

JOB-PROBLEMS STILL WITH US

BUSINESS SURGED UPWARD during all of the first quarter, and despite current recessions, the six-months totals are certain to top those of last year by a substantial percentage. Looking back at that progress now, however, it is apparent that it was uneven—badly unbalanced. The industries that make consumer goods, such as textiles and shoes, went ahead so rapidly that their unemployment problem practically disappeared. According to the most reliable estimates, less than 600,000 workers were unemployed in these plants, as compared with 5,000,000 in the construction and durable-goods industries and 4,000,000 in the services that depend largely on general business conditions. Obviously, then, the key to the unemployment problem lies in the latter fields. Until the durable-goods industries can share proportionately with the improvement in other industries, we cannot hope for well-balanced and permanent progress.

Chemical engineers have a real stake in the industries that make such things as buildings and machinery. Design and construction overshadow operation in number of jobs afforded for technical men. Furthermore, research and development suffer when there is no outlet for ideas to be translated into new plants and processes. Hence, as a group, unemployed chemical engineers have not been greatly benefited so far by the recovery process. The exceptions are those who have been engaged for the manufacture of consumer goods and, to a considerable extent, the youngest and inexperienced who are willing to start in at the N.R.A. "40-40" wages of the workman. But even the latter exception is encouraging news for the crop of ambitious graduates who leave our technical schools this month. May their jobs give them something more than blistered hands, as they master the intricate technique of the shovel and the wheel-barrow!

A job-selling campaign recently inaugurated by the A.S.M.E. in New York may prove to have some interesting possibilities. Recognizing first the fact that the consumer-goods industries probably hold the greater immediate opportunities, the plan is to sell the services of technically trained men for a wide range of non-technical positions. There is a further recognition of the fact that the average engineer is not a good salesman of his own qualifications, even though he often has greater-than-usual native ability. To remedy this, the employment service will engage the active help of a number of sales engineers who are in daily contact with employers in many lines of industry. These salesmen, as well as their employing firms, are willing to make this contribution to the society's efforts to find jobs, whether in engineering or out of it.

The permanent solution to the job problem, however, is not likely to be so immediate or direct. It lies in the restoration of confidence on the part of the whole business community. The recent report to the president by the Durable-Goods Committee of N.R.A. succinctly summarizes the remaining steps in the process of encouraging the flow of private capital into private enterprise. Only in this way can we achieve the essential balance in industry that means jobs for all of the 26,000,000 normally engaged in producing the goods required by our 130,000,000 goods-consuming Americans.

EDITORIALS

Whitman Goes Back to Tech

RETURNING to his old stamping grounds after eight years of distinguished service in industry, Walter Gordon Whitman has been appointed head of the department of chemical engineering at the Massachusetts Institute of Technology. Most of us in the profession will agree that there could be no more logical successor to the late Professor William P. Ryan, for Whitman was his closest friend, classmate and associate for a dozen years. His contributions to research while at the Institute have since served as the foundation for several of the outstanding theoretical developments in chemical engineering. In the petroleum industry he has seen and helped to translate theory into the best of modern practice. Experience thus gained will give added inspiration and direction to chemical engineering education.

Mushroom Growth Is Proving Unhealthy

DISTILLED liquor capacity of the United States is many times the estimated demand for consumption. The Government's figures which usually rate a distillery on the basis of one 8-hour shift for each of six days a week show generous capacities installed. But the real facts are even more appalling. Conservative and responsible estimates are that more than 400,000,000 proof gallons per year of distilled liquor could be made in present licensed establishments built or nearing completion.

Consumption estimates made by the industry at the time of repeal were about 140,000,000 proof gallons per year of distilled liquors. The Treasury estimates, on which anticipated tax income was based, called for about 80,000,000 gallons of domestic production and 25,000,000 gallons of imports. Experience the first months following repeal indicated an actual consumption of legal liquor at the rate of only about 40,000,000 gallons per year. This consumption may grow as hard liquor habits increase and as illicit distribution is eliminated by diligent tax collectors. But the actual requirements for domestic production certainly are going to be at the most only 15 to 20 per cent of potential capacity.

Even during the period for building up storage stocks for aging there is already at hand far more capacity than can be regularly operated. And yet demands for new licenses are occasionally still heard at Washington, especially from new incorporations.

Chemical engineers and those firms seeking contracts to build new plants must look carefully at the situation. Already some who started to build have found it necessary to discontinue operations through lack of funds. There may be more such obstacles in the way of builders. As Government limits on permits do not prevent mushroom growth, discreet limits on credit extended must do so.

Standards For Chemicals

AMERICAN STANDARDS ASSOCIATION and the U. S. Bureau of Standards have lately been discussing many phases of commercial standardization in an effort further to develop sound projects by joint action. This is important because Government funds were curtailed last year and additional effort of this sort must be made independently at the expense of industry.

In many lines of activity this work is important, particularly for goods widely distributed in trade such as appliances where simplified practice as to sizes and quality standards is desirable. However, there appears to be much less interest in this subject as it relates to chemicals, *per se*. Usually the practice of adopting "American Standards" is too slow to be effective where chemical goods used only in chemical industry are under consideration. Such trade standards must be changed more or less frequently. This is necessary to take account of changing customer requirements, new practices of production, improved methods of purification, and other factors.

Manufacturing Chemists' Association and specialized trade associations dealing with particular commodity groups can usually serve most effectively as a standardization agency for chemicals. There are, however, a few exceptions to this general rule. Such a commodity as storage-battery sulphuric acid is widely distributed among persons who do not have the technical information nor the facilities for controlling the quality of the chemical which they wish to buy. Such purchasers are entitled to protection and to knowledge that a certain grade, if specified and delivered, will be a suitable chemical for their use. For such a class of chemicals, the A.S.A. procedure is more appropriate.

Successful Meetings Can Be Held in New York

SEVERAL INTERESTING precedents were set and more than one of the Institute's inhibitions were upset as a result of the meeting in New York last month of the American Institute of Chemical Engineers—the first held there since 1918. Not only was it the largest in history, for over 500 members and guests were in attendance, but it was held at a time and place that had long been regarded as insurmountable hurdles. "Too many other attractions in New York! Too many other burdens on your industries. They can't and won't support a worthwhile convention." The answer is that they did, nobly, and that counter-attractions became less attractive when a program was laid out to take full advantage of New York's inherent technical and social attractions.

But perhaps the most lasting benefit to the profession will result from the provision for a special students' day program, cementing the already close relationship between the Institute and the schools in which chemical engineering is taught.

What Are the Prospects of a PETROLEUM CHEMICAL INDUSTRY?

Editor's Note. When Carleton Ellis addressed the recent New York meeting of the American Institute of American Chemical Engineers, on this subject, he spoke with unusual authority. For 20 years he has been intimately identified with some of the most important developments in the utilization of petroleum as a chemical raw material—ranging from the production of isopropyl alcohol from olefin gases to the synthesis of some of the newer oxidation products such as the fatty acids. His books are the standard text and reference works on petroleum chemistry. The most recent of these, published within the fortnight, is "The Chemistry of Petroleum Derivatives," a 1,285-page contribution to the literature of organic chemistry and industry. Only a few of the newer developments are reflected in this interview, given to a Chem. & Met. editor at the time of the A.I.Ch.E. meeting. Carleton Ellis' complete paper will be published in the Transactions of the Institute, Vol. 30.

An Editorial Interview With

CARLETON ELLIS

Industrial Research Consultant, Montclair, N. J.

Kaiden Studios, Inc.

NEW PRODUCTS derived from petroleum have been making their appearance in steadily increasing number and are fast assuming a more intimate relation to our daily lives. A profusion of alcohols and esters,—new organic solvents and anti-freeze compounds—have been produced from petroleum in recent years without arousing curiosity or attracting particular attention, but now that more familiar substances such as fatty and acetic acids, are being made from this source, the general public is beginning to realize that the long heralded petroleum chemical industry is approaching realization.

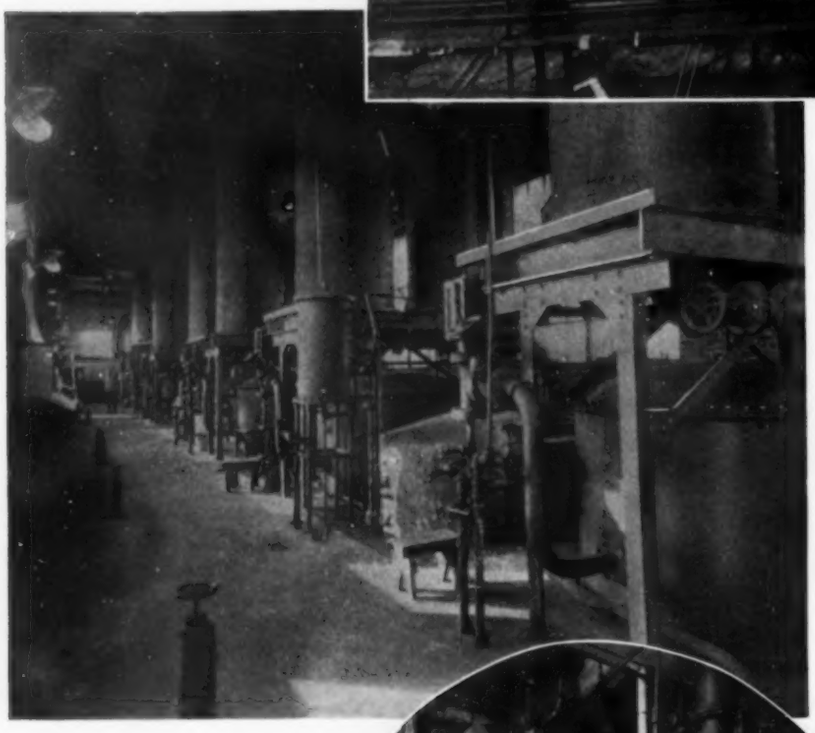
Interest in the chemical utilization of the aliphatic hydrocarbons has been greatly stimulated within the last few years by the development of more efficient methods and equipment for fractional distillation as a means of separating the lower-boiling constituents of petroleum and of fractional solution or solvent extraction as a means of isolating higher-boiling compounds. Considerable progress has been made in the production of pure compounds and the literature bearing upon their elaboration has become voluminous. (*Editor's Note:* Carleton Ellis' most recent book, "The Chemistry of Petroleum Derivatives," published June 1, 1934, by the Chemical Catalog Co., lists the contributions of almost 6,000 individuals whose articles or patents are of scientific or industrial interest in this field.)

Two processes, pyrolysis (thermal decomposition) and hydrogenation, have done much to bridge the gap between the older chemistry of coal tar and the newer chemistry of petroleum. In the past we have been dependent upon coal tar for many of the aromatic hydrocarbons desired for dyes and pharmaceuticals. Their quantity, and to a certain extent their number and variety, have been limited since coal tar, as compared with petroleum, is itself limited in quantity. Oftentimes elaborate and costly methods of synthesis are required to produce compounds which are not present as such in the tar.

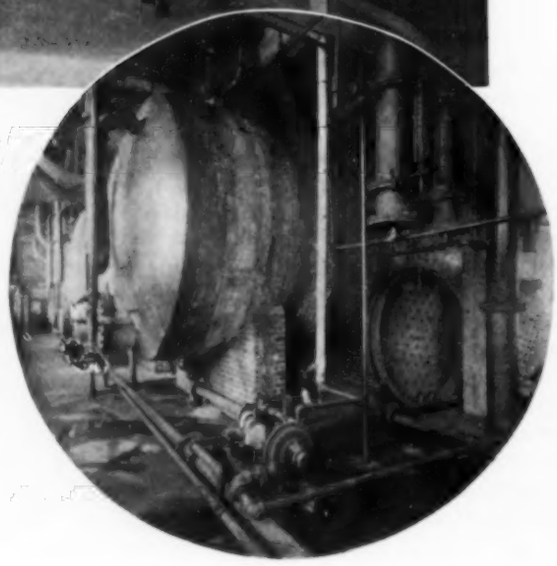
Recently as a direct result of the extensive development of hydrogenation processes, the petroleum industry has been able to produce a surprising variety of chemical compounds available in amounts limited only by plant capacities. Hydrogenated solvents, equivalent to benzol or toluol, are being made in tank car quantities at Baton Rouge, La. These are finding applications, not only in the usual fields of the paint, varnish, lacquer, resin and rubber industries, but also in a number of special uses where combinations of high solvent power and controlled evaporation rate is essential. Although these solvents are primarily substitutes for toluol, they do more than merely replace this coal-tar product. Certain of the solvents have much higher boiling points, ranging up to 450 deg. F., have gum solvency equal to that of toluol and in addition have special properties that make them

Alcohol Plant at Bayway, N. J., showing crude alcohol storage tanks in the foreground

Condensers and decanters used in refining isopropyl alcohol. The top of the bubble towers extend through the floor



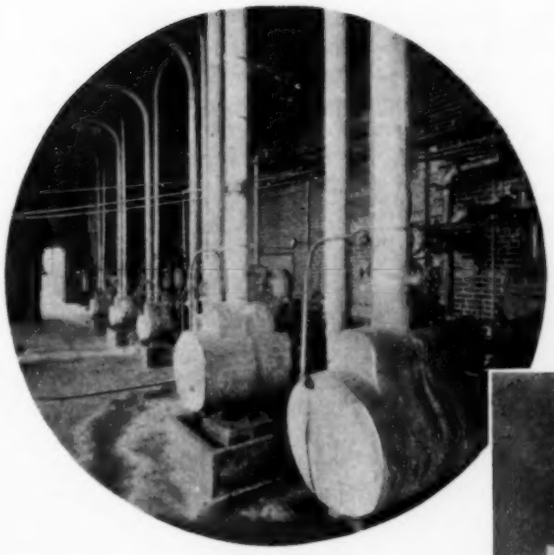
Drums in which petroleum alcohols are acetylated to form solvent esters



more desirable for specific applications.

Pyrolysis, particularly by some of the vapor-phase cracking processes, likewise yields many hydrocarbons similar to those of coal-tar origin. Since the presence of such compounds in gasoline increases its anti-knock value, there is at present an incentive to leave them in the finished motor fuel. However, petroleum technology has shown the way toward unlimited source of these hydrocarbons, and if it were necessary to extract them, say in the event of war to produce toluol for TNT, there is no longer any technical obstacle in the path.

Innumerable alcohols can be made from petroleum and at the present time, several are being produced in commercial quantities. One of the first of these was isopropyl alcohol available from petroleum under the trade name of Petrohol and largely used as a solvent, as a denaturant, and as a surgical antiseptic. It is produced solely as a byproduct of the petroleum and natural gas industries, by absorbing olefin gases, containing propylene, in sulphuric acid and hydrolyzing the resulting alkyl sulphuric acid. The crude alcohol is separated from the reaction mixture and purified by chemical treatment and further rectification (See *Chem. & Met.* 1920, Vol. 23, p. 1230; and Vol. 33, p. 402).

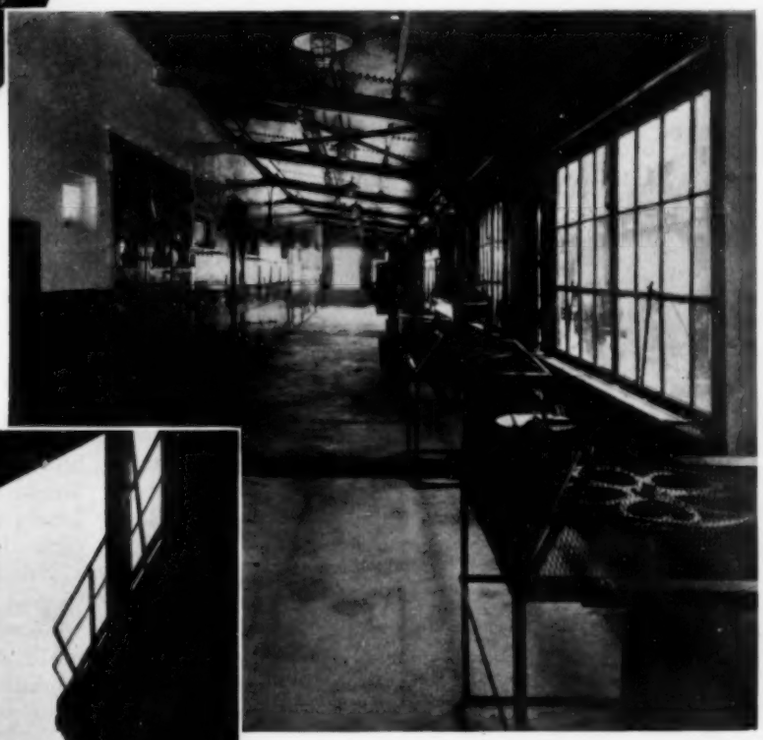


Insulated pumps used in handling butylene and other olefin gases

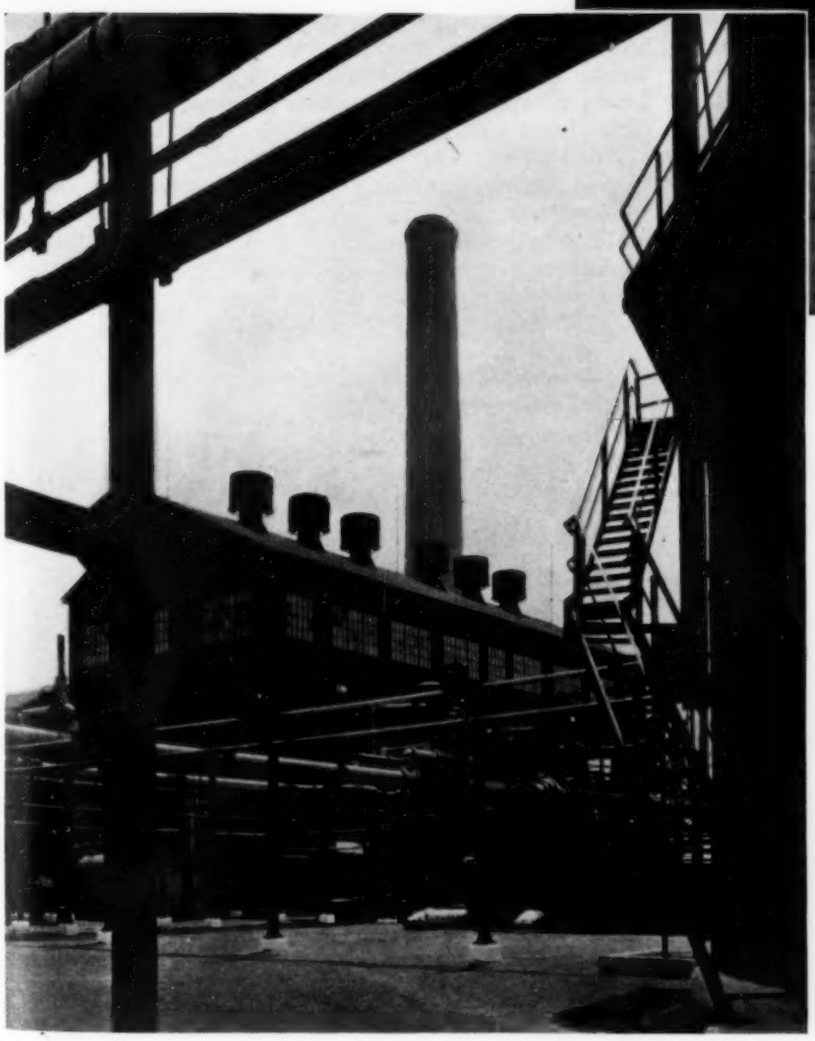
Ethyl alcohol has more recently taken its place as a petroleum chemical, synthesized from ethylene obtained in the vapor-phase cracking of petroleum. Again the quantity available from this source is limited only by plant capacity, and government restrictions on output.

New Oxidation Products

Oxidation of petroleum yields a variety of products and byproducts—in fact, one of the reasons that much of the earlier work with oxidation processes was unsuccessful commercially was the extreme difficulty in separating



A view inside the control house in the hydrogenation plant at Baton Rouge, La.



Here hydrogen is produced from refinery gases in two stages: First a direct cracking of the hydrocarbons to yield hydrogen and carbon monoxide, which reacting with superheated steam becomes hydrogen and carbon dioxide. The latter is removed by scrubbing water in the towers in the foreground

and marketing the wide variety of resulting products. More recently the approach has been more direct. Rather than using a "shot gun" attack and producing a lot of undesirable byproducts, "sharp-shooting" has been practiced; that is to say, purified raw materials have been used and operations controlled to yield a specific end product.

Some of the most interesting of these are the fatty acids obtained when paraffin wax is oxidized by being blown with air at a raised temperature. These acids, exactly similar to those from vegetable oils, can be used

in soap manufacture. Experimental work done in this field has produced soaps of petroleum origin which possess increased cleansing characteristics and lather instantly, even in hard water. It is believed that these hard water detergents, as they may be called, will find extensive application in textile processing, but they can also be used in the home. Shaving or shampooing with sea water is as easy as with fresh water when these new detergents are used.

Acetic acid, most important of the organic acids, and potentially the basis for a tremendous chemical advance in the rayon, cellulose and plastics industries, is also being made on a semi-works scale. Details of the process cannot yet be published, but in general it may be said that the raw material (hydrocarbon gases from the refinery), is cracked in an electric arc to produce acetylene, which is carefully purified, and converted into acetaldehyde and acetic acid. The final product is 98 per cent acetic acid and is used in the production of solvents, esters, which thus become of 100 per cent petroleum origin.

Rubber From Petroleum?

Despite the present low price of crude rubber and the efforts particularly by the late Thomas A. Edison to locate new agricultural sources, much interest has been displayed in the production of synthetic rubber from petroleum products. Naturally these developments are being followed with most interest in countries like the United States and Russia in which there are important petroleum deposits but no rubber plantations. Lately we have also seen the development of a rubber-like plastic derived from acetylene which, as indicated in the preceding paragraph, is now made from petroleum gases.

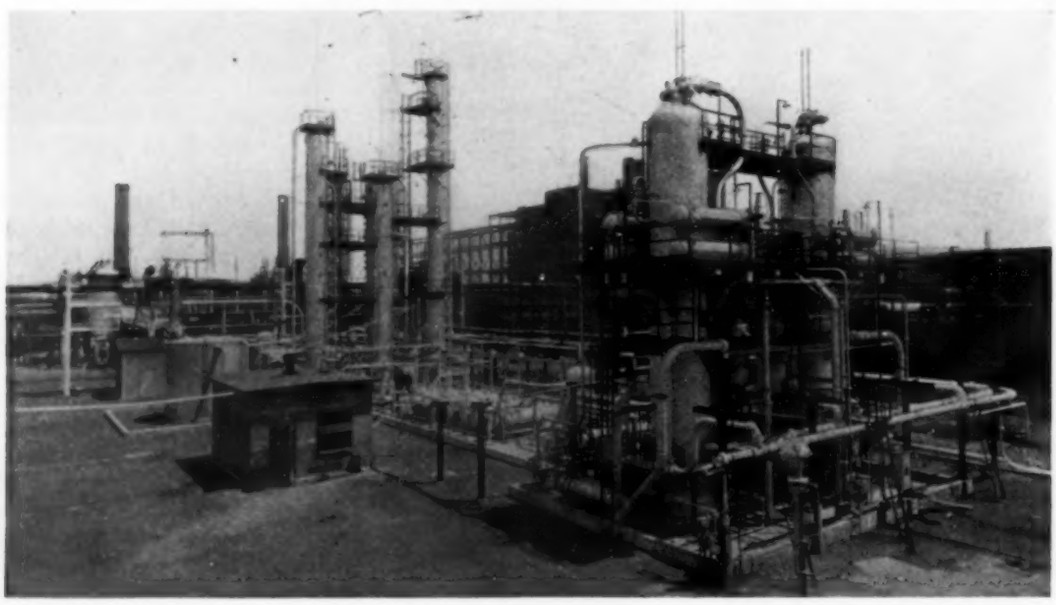
This new plastic material has many advantages over natural rubber and is able to compete with it under present conditions even though, of necessity, the price is considerably higher. It is insoluble in the usual rubber solvents and does not harden when exposed to certain materials that have a deleterious effect on the natural product. One application of this plastic is being made in the petroleum industry itself, viz., as a flexible hose for transporting petroleum distillates that cannot be handled in natural rubber. It is also being widely used in gaskets where resistance to oil is essential.

Another rubber-like product of this class is ethylene polysulphide produced by the interaction of ethylene dichloride and a soluble polysulphide. It is supplied to rubber and cable companies for fabrication in tubing, hose and molded parts such as gaskets, disks and washers. It, too, is unaffected by the swelling action of most of the solvents used in chemical industry.

A unique product of the petroleum industry is the disagreeable odor imparted by even extremely small quantities of certain sulphur compounds that are obtained in refining some petroleum distillates. Without any intention of doing the meat packers "one better" in their commendable efforts to conserve "everything except the squeal" some enterprising oil refiners are actually marketing these odorous byproducts which are being added to city illuminating gas to warn consumers when leakage occurs. The presence of these odorous compounds in city gas should make suicidal asphyxiation less frequent; certainly, less pleasant. Odorous detectors are of special importance to users of natural gas which, of course lacks any distinctive odor.

These are but a few of the many contributions that a petroleum chemical industry, in its endeavor to utilize more efficiently a great natural resource, has made to human welfare. Numerous others are reviewed in the Institute paper and in the author's newest book. Besides these direct contributions, however, an examination will reveal that not only have existing products been improved but simultaneously entirely new types of material have been developed. It is perhaps too early to appraise the ultimate value of these contributions, but certainly the new petroleum chemical industry has made some gratifying progress in recent years.

Gas absorption plant at Bayway, N. J., showing the debutanizers and stabilizers used in alcohol production

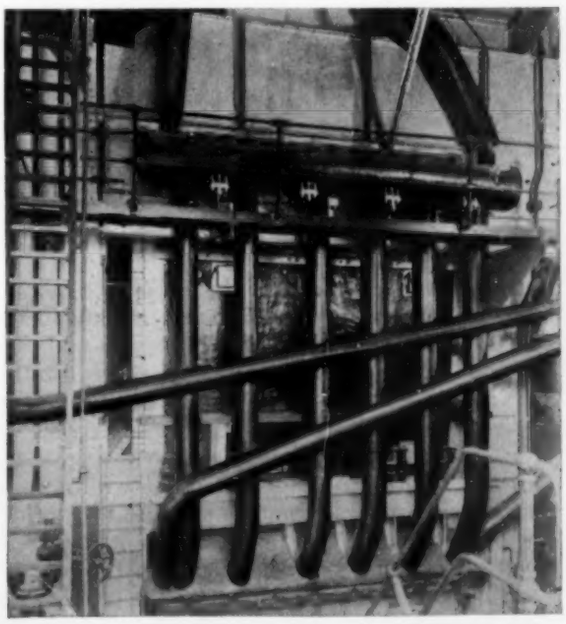


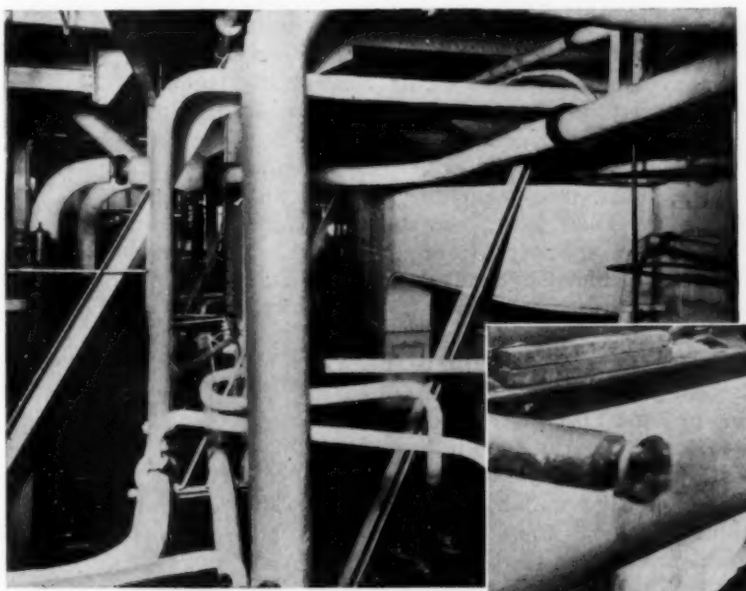
Glass as a Corrosion-Proof Heat Insulator

WHAT IS KNOWN as glass wool in the laboratory has become an industrial material of wide application in Great Britain. Toward the latter part of 1930, the glass concern of Chance Bros., Ltd., Glasgow, started production of "glass silk," and today, after much research, the process of spinning glass filaments from small electric furnaces has become an important industry in the Firhill district of Glasgow. The threads which are to be used in the construction of "Engineers' Eiderdowns" are spun from a high quality glass on to drums rotating at high speed, which take the threads and form long skeins of remarkable resilience. These skeins are also remarkable in possessing that "fire-polish" which was associated with old English crown glass. From the drums, skeins of appropriate length are cut, the material being ravelled and spread on long tables for the making-up of mattresses or layers for a specific purpose; no protection is necessary for handling by employees.

All the chemically resistant properties of glass are shown by the fibrous material, only hydrofluoric acid having any effect on it. Remarkable stability at all temperatures up to 1,000 deg. F., no tendency to disintegrate, complete permanence as regards hygienic properties, and a heat-reflecting power of surface, are essential values of this material. Its resilience is especially advantageous, for there is no tendency to change position or crack with expansion, contraction or vibration of the metallic surfaces to which it is applied. By far the most striking feature, however, is its ease of application, due to its greater width, which means fewer laps for a given area. Rapid wiring together of the sheets completes the job, as no backing is necessary. Outer layers are covered with wire netting when "mats" are used; but sheets sewn with asbestos thread are alternatives, while jute backing, fireproof paper, or asbestos backing may be included when desired.

Besides being corrosion-proof, non-hydroscopic and completely resistant to vermin, the material shows up advantageously as regards heat insulation efficiency in comparison with other common agents. In tests conducted by the National Physical Laboratory, the thermal conductivities of various thicknesses of glass silk layers ranged from 0.28 down to 0.21 B.t.u. per deg. F. per sq.ft. per hour per inch of thickness.





Above: Glass silk withstands vibration in the engine room of this train ferry

Upper Right: Experimental 1,500-lb. boiler built by B. & W. at Renfrew, Scotland, uses glass silk insulation on drum and piping

Right: Insulating high-pressure boiler drums in a large Scotch power plant

UTILIZATION OF CHEMICALS

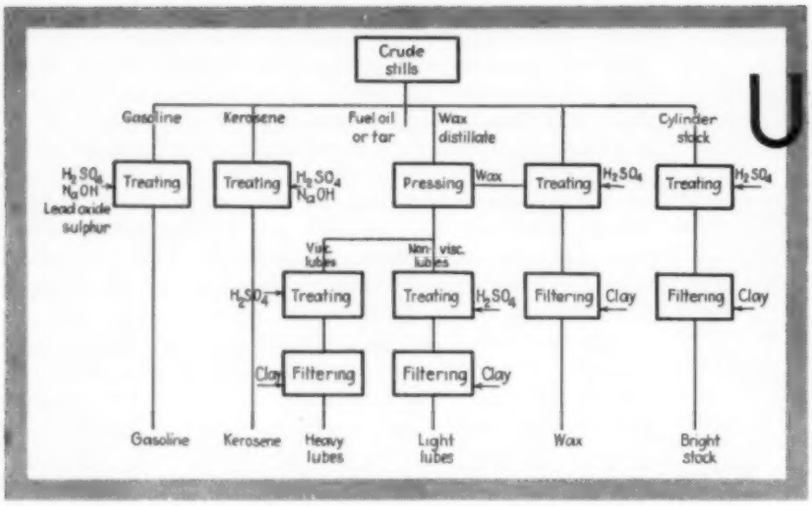


Fig. 1—Consumption of chemicals in petroleum refining prior to 1920

A DETAILED and comprehensive discussion of the chemicals used in the petroleum industry is obviously outside the scope of this paper. However, the three products of major importance requiring well over 90 per cent of all chemicals are gasoline, kerosene, and lubricating oil, and the general trend of chemical utilization is defined by them.

In the early days of petroleum refining sulphuric acid and caustic soda were the primary treating agents. Acid was used to remove sulphur, malodorous and bad colored compounds, while caustic was used for neutralization, and, mixed with lead oxide, to form "doctor" solution, to sweeten lighter hydrocarbons. While such treatment reduced the yield, it resulted in a gasoline with a more desirable odor and color, a kerosene with more satisfactory burning qualities and, in the case of lubricating oils from inferior crudes, a product more nearly approaching Pennsylvania quality than that of the raw stock.

Since good color and odor were the primary requisites, the objectionable materials removed were considered waste and the only thought regarding them was to devise a satisfactory means for their disposal. The economic situation did not demand that any real attention be given to the possibility of loss of valuable products due to overtreatment. However, during the past 15 years the various oil companies and affiliated industries have organized technical and scientific development on a large scale. This factor, together with the increased pressure of economic conditions, has introduced new chemicals and treating methods, with the result that the percentage of crude thrown away as sludge waste is much less than formerly, despite the more rigid specifications of the finished products. Whereas the only chemicals of importance were acids and alkali, they now range from these materials through special refining solvents to chemical addition agents which are used to modify the properties of the otherwise finished oils.

The diagram, Fig. 1, indicates very generally the important steps in oil refining in which chemicals were used prior to 1920. Use of sulphuric acid with the treating methods then employed to remove the undesirable sulphur, and unsaturated compounds, which accounted for the oil's bad color and odor, usually resulted in large losses. To make a satisfactory bright stock or a cylinder stock from Mid-Continent oils it was customary to use from 40 to 60 lb. of acid per bbl., each pound of acid causing approximately 1 per cent loss. Even with this loss the paraffinity of the final product did not equal that of Pennsylvania oil. As late as 1925 the cracked gasolines from some high sulphur crudes were treated with as much as 40 lb. of concentrated sulphuric acid per barrel. Such a treatment frequently resulted in as much as 50 per cent of the cracked distillate being discarded in the form of acid sludge. From some crudes it was impossible to produce a satisfactory kerosene.

These losses and changed economic conditions caused the industry to seek improved treating methods. The pertinent figures relating to the use of sulphuric acid in the petroleum industry are shown in Fig. 2. The total consumption increased from 522,060 tons of 50 deg. Bé. acid in 1919 to 1,483,863 tons in 1929 and then decreased to 1,240,000 tons in 1932. While the quantity used per barrel of crude has changed only slightly during this period, the improved treating methods are reflected in the decreased consumption per barrel of gasoline.

The major improvement was the substitution of continuous countercurrent treatment for the batch process. Various modifications of the continuous process have been made to control acid treating strength by sludge recirculation[1], contact time by the use of centrifuges[2], and temperature of treatment by refrigeration[3]. The net effect was an increase in the selectivity of the acid which reduced not only consumption but also sludge loss.

The total quantity of caustic used should be independent of acid consumption, as only the acid remaining after settling need be neutralized. Fig. 3 shows that the amount per barrel did remain reasonably constant until 1929. Thereafter there has been a definite reduction. Prior to 1929, there were improvements in caustic utilization of the same type as have been mentioned for

Condensed from a paper by the authors presented under the title of "The Trend of Chemical Utilization in Petroleum Refining" before the New York meeting of A.I.Ch.E., May 14-16, 1934.

IN PETROLEUM

REFINING

By P. C. KEITH, Jr., and H. O. FORREST

The M. W. Kellogg Co.
New York, N. Y.

acid and a decrease in the amount used per barrel would probably have been registered had it not been for the large production of high sulphur West Texas crude and the increasing tendency to combat corrosion with caustic. Since 1929 the gradual decline of the West Texas fields, the increasing use of "contact" clay for lube oil neutralization, and the improvement in treating methods, particularly the recovering of spent "doctor" solution, explain the declining consumption.

"Doctor" solution is a mixture of litharge and sodium hydroxide and is used to "sweeten" the lighter hydrocarbons. Prior to 1929 it was common practice to discard the spent solution. In 1929 the oil industry began to install recovery plants, in which the "spent" doctor was air-blown to oxidize lead sulphide to oxide. Small additions of lead oxide and caustic are made to keep the solution at full strength. Litharge consumption for the years 1929-32 was as follows: 1929, 13,615 tons; 1930, 12,028 tons; 1931, 7,331 tons, and 1932, 4,793 tons.

As already mentioned, the use of acid and caustic imposed quality limitations, which the oil industry was anxious to avoid. Probably the first step in removing these limitations was the introduction of the Edeleanu SO_2 process[4]. From some California crudes it was impossible to produce with acid a kerosene possessing satisfactory properties. In 1925 the first American Edeleanu plant was installed. Being much more selective than acid, a better product resulted, and as removal of undesirable constituents takes place by physical solution rather than by drastic chemical reaction, the deterioration of oil to acid sludge was minimized. This process is the forerunner of the more selective and less destructive solvents to which the industry is now rapidly turning. Today 35 Edeleanu plants have been installed throughout the world, with a total daily treating capacity of 78,000 bbl. of light oil and 13,000 bbl. of lubricating oils. Ten of these plants, with a capacity of 36,000 bbl., are in America.

The increased use of chemicals in the petroleum industry is indicated by the diagram of Fig. 4. As before, sulphuric acid still predominates, but other materials have assumed important places. In one refinery, operating on a relatively low grade crude, the cost of acid was only 20 per cent of the total cost of chemicals, although the quantity was over 85 per cent of the total. The cost of basic chemicals, including acid, alkali, litharge, and sulphur, was only 40 per cent of the total, small quantities of the more expensive chemicals being responsible for the remainder.

Gasoline treating has always been the major use of the sulphuric acid. Its action is not one of real selectivity and it became increasingly evident that serious losses were taking place by polymerization and solution in the sludge. With the development of cracking, and the consequent increase of the unsaturated constituents in the gasoline, the reduction of this loss became of major importance. In addition, in 1926 the anti-knock characteristic of a motor fuel began to be increasingly important. Higher temperature cracking to produce higher anti-knock gasoline resulted in untreated products with

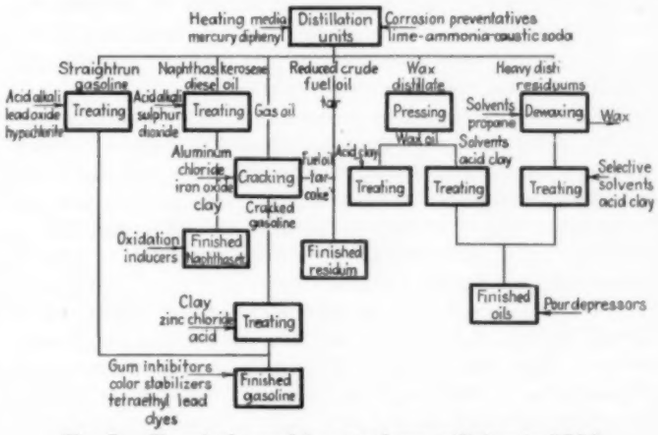


Fig. 2—Chemicals used in petroleum refining in 1934

a large proportion of unsaturated compounds. Conventional methods of treating gave not only lower yields but marked reduction in anti-knock value, and it became imperative to decrease treating losses. The improvements in acid treating have already been mentioned. But however acid is used, it results in a loss of yield and of anti-knock value.

Substitution of clay treating of the cracked gasoline, particularly in the vapor phase, as in the Gray process, has been an important factor in reducing the consumption of chemicals and in retaining the desirable materials in the finished product. Unfortunately, the clay process does not remove sulphur and consequently large quantities of cracked gasoline are still acid treated. Following clay treatment the gasoline must be sweetened, but the marked loss of yield and anti-knock value is avoided However, if the 100,000 bbl. per day of cracked gasoline now clay-refined were treated with acid the consumption would be an appreciable portion of the total. Competitive with the Gray process is the Lachman process[5] which treats gasoline vapor with zinc chloride. The loss of zinc chloride is extremely small, the chemical apparently acting as a catalyst.

These new developments in the refining of gasoline

may be considered as direct color and gum removing processes, rather than as processes for removal of unsaturated hydrocarbons. They are indicative of the general trend toward greater selectivity in the action of chemicals. The aim is to remove only those constituents which are a definite disadvantage in the finished product.

The trend is even more marked than is indicated. Instead of treating to a satisfactory gum content, the tendency is to proceed only part way and add inhibitors of gum formation. The government's ruling that gasoline containing tetra-ethyl lead had to be dyed a distinctive color opened the way for colored gasolines. Because of the increasing percentage of cracked gasoline the refiner found it more and more difficult to produce a color-stable product. Since color, as such, has no effect on motor performance and the achievement of a color-stable product by refining methods is more expensive than by adding dyes, almost all gasoline is now colored. These expedients have resulted in a greater yield of a product which is fully as satisfactory.

One of the greatest developments, from a chemical viewpoint, is the use of tetra-ethyl lead to reduce the tendency to detonate. Although no figures are available on the use of this material, it probably represents the major chemical cost to most refiners.

Treatment of gasoline to produce a satisfactory and salable product has therefore changed from a drastic chemical reaction with large losses to one in which the treatment is more selective and is carried only far enough to produce a satisfactory and stable product with chemical additions compounds insuring satisfactory color, gum, and performance characteristics.

What has taken place in gasoline refining technique is taking place in the technique of lubricating oil manufacture. The period from 1920 to 1932 saw an enhanced production of lubricants by vacuum distillation. This procedure eliminated a large part of the acid required for treating. Acid consumption was further reduced by removing more color units by contact filtration. Incidentally caustic consumption decreased since the clay satisfactorily neutralized the remaining acid. During part of this period some refiners were able to select stocks for the production of lubricating oil which required a minimum of treating to bring them to satisfactory specifications. However, an offsetting influence, increasing the use of acid, was the trend toward lighter colored lubricating oils.

Forced partly by competition, but also by improved motor design and the increased use of cars, there has been a marked tendency to stress characteristics of lubricating oils which were not considered ten years ago. Among these the most important from the viewpoint of the chemical industry are viscosity index, resistance to sludging and oxidation, and pour test. Most refiners believe that they will be forced to manufacture motor oils having a viscosity index of 100 and a pour point of 0 deg. F., if for no other than sales reasons.

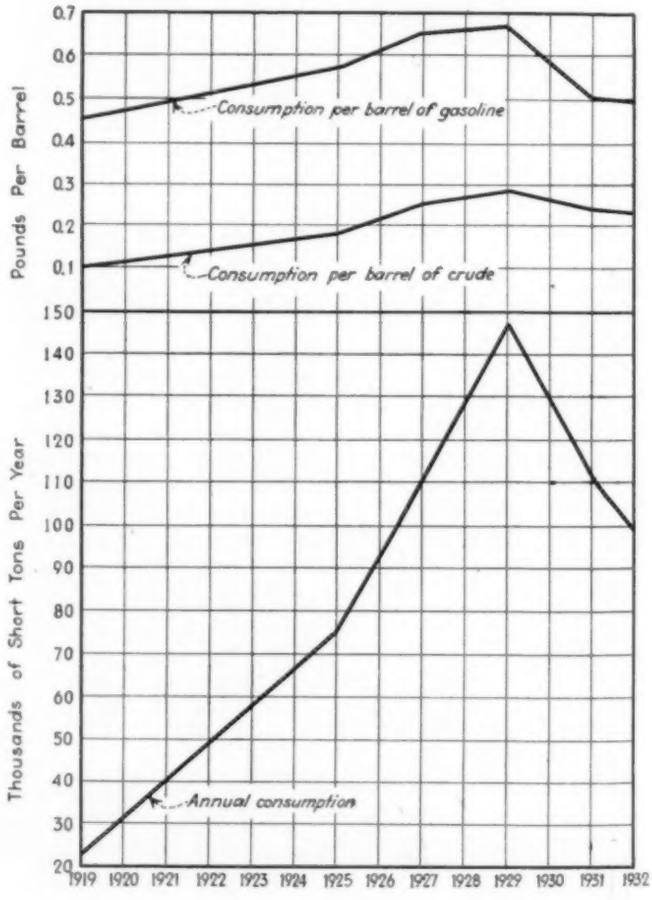
In general, the widely used present-day methods will not treat and dewax sufficiently well to fulfill these requirements. This fact is of importance to the chemical industry since the oil industry may look to it to supply dewaxing and treating solvents. While the production of lubricating oil may not increase, it is probable that the amount of oil to be dewaxed to produce the same quantity of lubricants will increase. This is true because those crudes having a low wax content also generally contain little oil of high viscosity index. It is also probable that the crude run to lubes will increase because the yield of a 100 V. I. oil will be less than the present lube yield. This lower yield is caused not by the deterioration of the crude by the treating methods contemplated but by the radical improvement of the motor oil. From most crudes this improvement is not economically possible by acid technique. The undesirable constituents removed by a selective solvent are utilizable as fuel oil or cracking stock, whereas acid sludge presents a disposal problem.

The processes which have been developed for improving these two characteristics of lubricating oil, although essentially physical in operation, require large quantities of chemicals which are relatively new to the petroleum refining industry. The new processes developed for dewaxing are: (1) Benzol-acetone process[6]; (2) chlorinated solvents process[7]; (3) propane process[8].

During 1929 the lubricating oil production as shown in Table I was approximately 34,000,000 bbl., or nearly 100,000 bbl. per day. Although the production has decreased somewhat since that time, it may be safely assumed that it will return to at least this value in the near future. This is particularly true in view of the increased tendency for motor manufacturers to recommend lower viscosity oils, with a consequent increase in consumption.

In the practical operation of these processes it is

Fig. 3—Consumption of caustic soda, including equivalents of soda ash, in petroleum refining



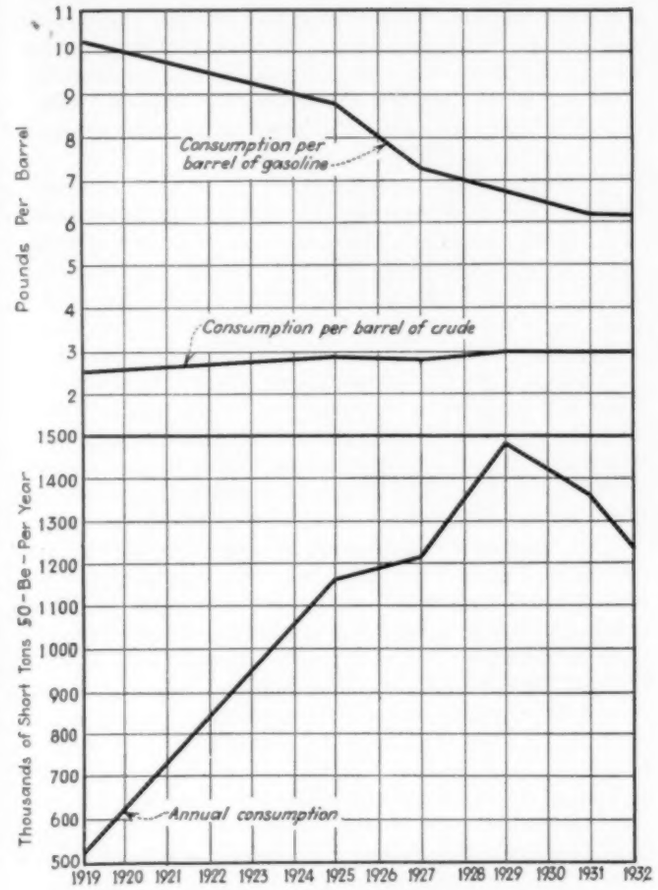

Pounds Per Barrel
Consumption per barrel of gasoline
Consumption per barrel of crude
Thousands of Short Tons 50-Be- Per Year
Annual consumption
1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932

Fig. 4—Sulphuric acid consumption in petroleum refining

inevitable that some of the chemical be lost, and it has been indicated that the magnitude will be about 0.1 per cent of the amount circulated. On the assumption that 10,000 bbl. per day, or 10 per cent of the 1929 production, may be allocated to each of the three processes, it is possible to arrive at a quantity of each of the solvents which may be required.

The total quantity of lubricating oil fractions charged to the dewaxing process will be much greater than the final production. For example, if a wax-bearing California residuum such as Kettleman Hills is to be processed, with about 25 per cent removal of the asphalt by distillation, or by propane deasphalting, 10 per cent removal on dewaxing and 35 per cent removal on solvent treating, all based on the original residuum, the net charge to the dewaxing plant will be 250 per cent of the finished oil if dewaxing occurs prior to treating, and 133 per cent if dewaxing follows treating. In the case of a Mid-Continent oil the corresponding figures would be about 200 per cent and 125 per cent, respectively. A reasonable estimate of the charge to dewaxing plants in each process is, therefore, about 18,000 bbl. per day.

The average composition of the solution being dewaxed will be approximately 25 per cent oil and 75 per cent solvent. The solvent circulated per day would then be 54,000 bbl. and a reasonable quantity for initial operation would be about one-half of this quantity, or 27,000 bbl. The loss at 0.1 per cent would be 54 bbl. per day, or nearly 20,000 bbl. per year. If this capacity is to be installed over a three year period, the solvent requirements during the first three years would be 12,300, 19,000, and 25,700 bbl. and subsequent to that time 20,000 bbl. per year.

In the use of the acetone-benzol process the average composition of the solvent will probably be about 65 per cent benzol and 35 per cent acetone, although present developments indicate the possibility of using 53 per cent benzol and 13 per cent toluol. On the latter basis the approximate quantities of benzol, toluol and acetone required would be 440,000, 109,000 and 294,000 gal. per year. The quantity of nearly 2,000,000 lb. of acetone per year is a considerable fraction of the actual production of this chemical. Additional demand for this material is an important item to the chemical industry and one example of the trend toward more costly chemicals. The demand for benzol would not have an appreciable effect on the supply. The toluene demand could be readily supplied in normal times, but might be a factor when it was in great demand for the manufacture of explosives. Propane used in the propane dewaxing process[8] is only a very minor fraction of the available supply and as it would normally be a product of the petroleum industry, its effect on the chemical industry is of no importance.

The chlorinated solvent processes again require relatively large quantities of higher priced chemicals. The material disclosed as the solvent in this process in Pester's paper[7] was trichlorethylene, and although the Bachlund patent discloses other chlorinated compounds of this type which may be used as the diluent, this material may be considered as typical. Under the previous assumption of 840,000 gal. or 10,800,000 lb. per year, the demand would require a large increase in present capacity.

These developments in dewaxing of lubricating oils have resulted in the introduction of at least two new chemicals, trichlorethylene and acetone, and three hydrocarbon solvents, benzol, toluol, and propane. Newer developments in solvent treating processes are responsible for many more, the more important of which, as disclosed at the recent meeting of the A. P. I. are:

1. Chlorex process—using B-B'dichlorethyl ether.[9]
2. Crotonaldehyde process.[10]
3. Duosol process—using propane and cresylic acid.[11]
4. Edeleanu process—using sulphur dioxide, alone or with benzol.[12]
5. Furfural process.[13]
6. Nitrobenzene process.[14]
7. Phenol process.[15]

The primary purpose of solvent treating is improvement in the quality of lubricating oil, particularly with regard to viscosity index. At the same time, an improve-

Table I—Petroleum Statistics

(A.P.I. Statistical Bulletin, 1933)

Year	Crude Consumption, 42-Gal. Bbl.	Gasoline, 42-Gal. Bbl.	Lubricating Oils, 42-Gal. Bbl.
1919	422,740,000	99,648,000	20,161,000
1920	521,876,000	122,259,000	24,438,000
1921	520,044,000	130,900,000	20,896,000
1922	584,547,000	150,054,000	23,304,000
1923	715,980,000	192,650,000	26,168,000
1924	752,458,000	228,650,000	27,498,000
1925	828,885,000	266,810,000	31,055,000
1926	842,082,000	304,493,000	32,293,000
1927	879,037,000	337,348,000	37,721,000
1928	950,066,000	384,913,000	34,658,000
1929	1,024,039,000	441,804,000	34,359,000
1930	952,998,000	441,702,000	34,201,000
1931	913,759,000	440,011,000	26,704,000
1932	831,341,000	402,063,000	22,433,000

ment in color, Conradson carbon, and resistance to oxidation is obtained. A simple concept of the untreated oil is a mixture of three major classes of compounds, asphalt, naphthenes, and paraffins. The asphaltic materials can be separated to a major degree by distillation under vacuum, by precipitation from a propane solution of the oil[16], or by the solvent itself.

The oil will contain naphthenes and paraffins in varying proportions; for example, in Pennsylvania oils the proportion may be as high as 90 per cent paraffins, while in California oils from waxy crudes it may be as low as 50 per cent, of which one-half is wax. In non-waxy crudes the paraffin content may be so low that economical recovery is impossible. A desirable solvent treating process is one which selectively separates the undesirable naphthenes from the desirable paraffins, and permits recovery of both without serious impairment. In this respect particularly it differs from the older acid treating process which merely removed the minimum of color.

Many Possibilities in New Materials

All of these processes depend upon selectively absorbing the naphthenes in the solvent; the feasibility of using any particular solvent depends on factors such as selectivity, or ability to dissolve a maximum of the naphthenes and a minimum of paraffins, cost, availability, ease of recovery, stability, and chemical inertness. Many compounds have been investigated[17], and although the seven materials that have been developed may seem extensive, they represent only a small fraction of the possibilities.

As in dewaxing, it is impossible to determine the possible requirements of these chemicals for the oil refining industry, particularly since the proportion assignable to each of the seven processes depends on so many factors. The total daily lubricating oil production of 100,000 bbl. has been estimated as divided into 30 per cent from Pennsylvania base, 32 per cent from mixed base similar to Mid-Continent, 31 per cent from Coastal, and 7 per cent from California. The treatment to reach a given viscosity index varies widely with the source. For example, it is possible to obtain about 100 V.I. oil from Pennsylvania crude without solvent treating or with 100 per cent yield based on oil as finished today. With California wax-bearing crudes such as Kettleman Hills, however, the yield might be only 35 per cent and for Mid-Continent oils only 75 per cent of present yields. With non-waxy California or Coastal oils the yield would be low enough to make their use uneconomical. In view of the probability of some use of solvents even on Pennsylvania oils to increase the viscosity index beyond the value which would be feasible for other oils, it is probably fair to assume an average treating yield of about 70 per cent. On this basis the quantity of oils to be treated would be approximately 140,000 to 200,000 bbl. per day, depending on whether dewaxing followed or preceded treating. Assuming 10 per cent of the lower figure would be treated by each of the seven processes and 300 volumes of solvent per volume of oil treated, the actual daily throughout of solvent would be 176,000 gal. With the loss at only 0.1 per cent, the replacement would be 640,000 gal. of each of the solvents mentioned.

An indication of the possible effect of the demand for these materials on the chemical industry may be obtained by comparing the above figures of 640,000 gal. per year with the present production and consumption. For 1931 and 1932 the only figures available are for cresylic acid and phenol. The 640,000 gal. or 5,600,000 lb. per year is more than 50 per cent of the cresylic acid production in 1931 and more than 100 per cent of the sales in 1932. It is even 45 per cent of the phenol sales in 1932, as reported to the U. S. Tariff Commission.

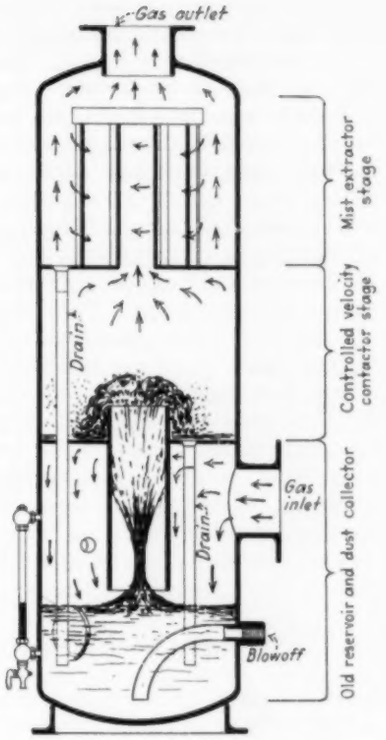
No mention has been made of chemical agents which may be added to lubricating oils in much the same manner as addition agents are added to gasoline. At the present time there is a widespread use of the pour-depressor Paraflow, which may be added to a partially dewaxed oil to decrease its pour point from approximately 15 deg. to 0. deg. F. Other addition agents, such as some oleates and stearates, are added to enhance the ability of the oil to form and maintain a film over metal surfaces. Still another chemical will markedly increase the viscosity index.

This trend may be emphasized still further as one away from destructive inorganic chemicals, through less destructive inorganic chemicals to selective and non-destructive organic chemicals and addition agents. During the early part of this period the trend may be considered gradual, with no marked entrance of the chemical industry into oil refining. The first major development, requiring the refiner to relinquish his essentially self-contained position, was the introduction of tetra-ethyl lead. Its significance cannot be emphasized too greatly, because it marked the beginning of the industry's acknowledgment of addition agents. Any prophecy of the future trend of chemical utilization in the petroleum industry is of necessity visionary, but it may be safely stated that it will continue toward more complex and selective materials, and that high yield of high quality products will be more and more important as the supply of high quality crudes decreases. Addition agents for increasing the apparent viscosity index and siudging characteristics of lubricating oils and competitive anti-knock compounds for gasoline are probable developments. Catalytic cracking and addition of some chemical during the cracking operation to produce high anti-knock compounds directly in the gasoline, are distinct possibilities. Certainly the selective treatment of lubricating oils, and possibly of other fractions, is still in the preliminary stages from a chemical viewpoint.

1. W. W. Gary, U. S. Patent.
2. Walter Cross, U. S. P.; C. W. Stratford, U. S. P.
3. An Improved Method of Refining Cracked Naphtha: A.P.I. Bulletin, Vol. IX, No. 7, P. A. Halloran.
4. Action of Sulphur Dioxide on Mineral Oils: *National Pet. News*, Vol. 23, No. 7, A. H. Foster.
5. Zinc Chloride Improves Color Stability, Reduces Gums in Gasoline: *National Pet. News*, Vol. 23, No. 45, A. Lachman.
6. Solvent Dewaxing of Oils with Benzol Acetone: A.P.I. Proceedings, Vol. 14M, No. III, Francis X. Groess and G. R. Bryant.
7. Centrifuge Dewaxing with Trichlorethylene: A.P.I. Proceedings, Vol. 14M, No. III, Carl F. Pester.
8. Dewaxing Oils in Propane Solution with Self Refrigeration: A.P.I. Proceedings, Vol. 14M, No. III, W. H. Bahlke, R. H. Giles, and C. E. Adams.
9. The Chlorex Process for Producing High Grade Lubricating Oils: A.P.I. Proceedings, Vol. 14M, No. III, W. H. Bahlke, A. B. Brown, and F. F. Diwoky.
10. Solvent Extraction and Its Application: A.P.I. Proceedings, Vol. 14, No. III, J. W. Poole and J. M. Wadsworth.
11. The Relation of the Duosol Process of Solvent Extraction to Other Processing Steps Necessary to the Manufacture of Lubricating Oils: A.P.I. Proceedings, Vol. 14, No. III, M. Tuttle and M. B. Miller.
12. Scope and Flexibility of the Edeleanu Processes: A.P.I. Proceedings, Vol. 14, No. III, O. P. Cottrell.
13. Refining of Lubricating Oils by Solvent Extraction and Furfural: A.P.I. Proceedings, Vol. 14, No. III, R. E. Manley, B. Y. McCarthy and H. H. Gross.
14. The Nitrobenzene Process—Installation and Manufacturing Costs: A.P.I. Proceedings, Vol. 14, No. III, S. M. Ferris, W. A. Myers and A. G. Peterkin.
15. The Use of Phenol as a Selective Solvent in the Production of High Grade Lubricating Oils: A.P.I. Proceedings, Vol. 14, No. III, R. K. Stratford, O. S. Pokorny and J. L. Huggett.
16. The Use of Propane in Lubricating Oil Refining: A.P.I. Proceedings, Vol. 14, No. III, U. B. Bray, C. E. Swift, and D. C. Carr.
17. Solvent Extraction of Lubricating Oils: *Jour. Ind. & Eng. Chem.*, Vol. 23, p. 753, S. W. Ferris.

New Methods And Problems in GAS ENGINEERING

By R. S. McBride
Editorial Representative, Chem. & Met.



Oil scrubber

GAS ENGINEERS and chemists meeting in their most important technical session of the year conferred May 21 and 22 in New York under the auspices of American Gas Association. This joint conference on production and chemical questions was held under the auspices of the two main technical committees of A.G.A., Gas Production Committee, J. V. Postles, chairman, and Chemical Committee, E. F. Pohlmann, chairman. Approximately 350 technical men participated in the sessions.

Outstanding problems today that worry the production executive center in the field of mixed gases. Many of these problems arise from the extensive use in city supply of natural gas, either mixed with other manufactured gas or partly reformed to produce lower heating value than the natural product and modified chemical characteristics wanted to facilitate convenience in utilization for appliances formerly burning manufactured gas.

The major activities of the water gas engineers, working in a subcommittee under H. B. Young of Chicago, are related to the production of a gas for such mixing with, or substitution for, natural gas. Interruptions of natural gas supply make emergency standby operation of plant equipment vital to city service. If it were only necessary to produce a combustible gas, this would be easy. But substitution for good service requires maintenance of heating value, specific gravity, and combustion characteristics within the limits tolerable by the ordinary customer's appliances. Fortunately only a few companies have been confronted with a large emergency of this nature; but enough experience has been gained, and was reported at the Conference, to reliably forecast available methods.

Chicago experience as reported by P. E. Eddy indicates that minor equipment modifications are vital. Much improved steam-metering appliances and more adequate oil-handling equipment for water-gas sets are required. For machines that are slow in picking up heat in the superheater or machines that tend to have colder superheaters than carburetors, additional superheater blast connections are also needed. Assuming proper equipment, Eddy summarizes practical methods on the basis of Chicago experience, as follows:

The B.t.u., specific gravity, and volume control is important. It is more difficult to keep the B.t.u.'s down to 800 than to raise them. The specific gravity curve follows the B.t.u. curve; that is, a high B.t.u. will give a high gravity, and so forth. High B.t.u.'s (above 840) are an indication of (1) cold machine; (2) unbalanced heats in the machine (hot and cold spots); (3) too short a time of contact (too much oil and steam or too low heats); (4) improper ratio of oil and steam. A low B.t.u. with a light gravity indicates that the oil is being cracked into hydrogen, caused either by excessive heats or insufficient steam and oil. The volume produced should be comparable with good 530 B.t.u. operation without "blow runs."

The production of high B.t.u., light gravity gas is dependent upon the breaking up of oil gas beyond "illuminants." This method of operation is attempting to get the maximum methane yield from the oil, methane being a very slow burning gas. In producing this methane, some hydrogen is necessarily formed. Hydrogen will reduce the gravity but is very fast burning, and, therefore, should be held to a minimum. Also with the production of hydrogen, free carbon is formed.

Carbon, tar, and water will form very stiff emulsions. Oil added to this makes it worse. The heaviest of these emulsions are formed and stay in the wash box, and if neglected are apt to cause trouble. The bottom drain of

the wash box should be opened for a short duration at very frequent intervals and, likewise, the seal pot should also be drained to prevent plugging. Plenty of water should be used in flushing the seal pot to prevent a mass of heavy material from blocking the sewer.

Somewhat analogous experience has been had at St. Louis from which the engineers of Laclede Gas Light Co. summarize their findings convincingly, as follows:

Mixed gas distributed is 800 B.t.u. of approximately 0.57 sp.gr. made up of a mixture of oven, producer, oil still, and natural gas. The proportions vary depending on the load, the producer gas being used to maintain the specific gravity. A gas of 0.57 to 0.60 sp.gr. and 820 B.t.u. will operate well on local appliances, the one exception being a radiant fire with a Saxophone burner. In order to get a gas of this type it is necessary to crack illuminants to obtain high methane and make very little blue gas. To do this the steam meters should be changed so that these low flows can be accurately controlled both for the run and during the blow when steam is added to help control the fire conditions.

High B.t.u., High Sp.Gr. Gas

It is easier to make a high B.t.u., high specific gravity gas and the gas makers who have previously operated on a 600 B.t.u. gas must entirely change their viewpoint. When the B.t.u. is higher than desired their natural reaction is to cut the oil. This, of course, immediately reduces capacity. The remedy for high B.t.u. is increased heats or slightly increased steam. However, increased steam means increased CO and hydrogen and these gases give objectionable burning characteristics to the resultant gas. The water gas set seems much more critical when making a high B.t.u. gas, which is logical as the greater part of the make is oil gas and is therefore very sensitive to change in temperature. The scurfers in the carburetor helped control the carbon. The extremely heavy tar was handled by increasing the circulation on the wash-box of the set.

Actual emergency-scale work of this sort was reported by George Wehrle, superintendent of the gas department at Denver, where last fall substitution of the entire city requirement was necessary when a flood washed out the natural gas pipe line leaving the city for 42 hr. without outside supply. Using oil to heat up the sets the make was brought up to capacity quickly. Production of a furnished gas of 1,000 B.t.u. per cu.ft. and 0.68 sp.gr. was accomplished with 1 gal. of fuel oil and 10 gal. of make oil per M, with a tar byproduct of 1.5 to 2.0 gal. per M. The gas proved wholly satisfactory as a substitute for the regular natural supply.

Substituting heavy oil for higher cost gas oil as a measure of economy is a problem of importance, especially along the Atlantic Seaboard. The mere technical problem is here subordinate to the economic one. The over-all economic balance with attention to carrying charges on additional equipment, increased labor charges, and modified return from tar byproduct, must be taken into account. Naturally the advantages in any locality depend largely on the relative prices of the two types of oil. Furthermore, the use of heavy oil as a substitute in part for solid fuel must always be considered and the price differentials between solid fuel and heavy fuel oil, therefore, enter as a secondary, but important, problem.

Experience in Brooklyn on the use of the heavy-oil process was reported at the Conference by A. H. Schaaf. His experience was peculiarly significant because the location of the plant where substitution took place required wholly smokeless operation to avoid nuisance in neighboring residential territory. Because of varying price relationships, the favorable conclusions reached in Brooklyn may not be generally applicable; but the experience there shows the technical success and some of the secondary complications to be taken into account.

One of the complications incident to heavy oil operation was experienced in the handling of the tar emulsions formed. Experience in many other places, as well as Brooklyn, shows that some such emulsions are not readily broken by the ordinary heating-up process, apparently because of the emulsifying influence of the "asphaltines." However, emulsions of high water content can be burned successfully, up to 20 to 30 per cent water if necessary. A small loss in burner efficiency is observed, amounting to approximately 2 per cent when 25 per cent water is present in the tar.

In considering oil substitutions, the modified value of the tar as a boiler fuel is usually taken into account. However, if the tar has a sales value, then change of that is usually more important than change in boiler usefulness.

Substitution of oil for solid fuel by injecting some of the oil on top of the solid fuel fire has become a frequent practice in the industry. Comments at the Conference indicated that such substitution can usually not go beyond the point of using 8 to 10 lb. of solid fuel per M made.

The use of petroleum refinery byproduct gas to enrich city supply is becoming generally more important. The experience of the Laclede Gas Light Co. at St. Louis was, therefore, received with interest. The experience of Brooklyn in the use of oil gas for cold enrichment, briefly reported in *Chem. & Met.*, was also summarized, as was a certain Boston experience.

It will be noted on the chart that the over-all thermal efficiency, measured in terms of output heat over input heat, varies with the quantity of refinery-still gas used. This is to be expected because that gas used for cold enrichment is applied with 100 per cent thermal efficiency. It is, therefore, substituted for some of the carburetting oil which necessarily is used at an efficiency of not over

Results of production of reformed natural gas from Texas gas

Reformed gas made	1,836,960	M. cu.ft.
Natural gas used	893,293	M. cu.ft.
Total runs	88,868	
Generator fuel used	16,263,898	lb.
Generator steam used	39,004,816	lb.
Steam produced	11,432,721	lb.
Reformed gas per run	20,670	cu.ft.
Reformed gas per machine per day	6,194	M. cu.ft.
Generator fuel per MCF reformed gas	8.85	lb.
Generator steam per MCF reformed gas	21.23	lb.
Natural gas per MCF reformed gas	486	cu.ft.
Steam produced per MCF reformed gas	6.22	lb.
Average B.T.U. per cubic foot of reformed gas	547	
Heat Balance:		
Input—Natural gas—486 cu.ft. at 1040 B.T.U.	505,440	B.T.U.
Generator fuel—8.85 lb. at 13500 B.T.U.	119,475	B.T.U.
Generator steam—21.21 lb. at 1156 B.T.U.	24,519	B.T.U.
	649,434	B.T.U.
Output—1,000 cu.ft. reformed gas at 547 B.T.U.	547,000	B.T.U.
Steam made—6.22 lb. at 1197 B.T.U.	7,445	B.T.U.
	554,445	B.T.U.
Ratio of Output to Input	85.4 per cent	

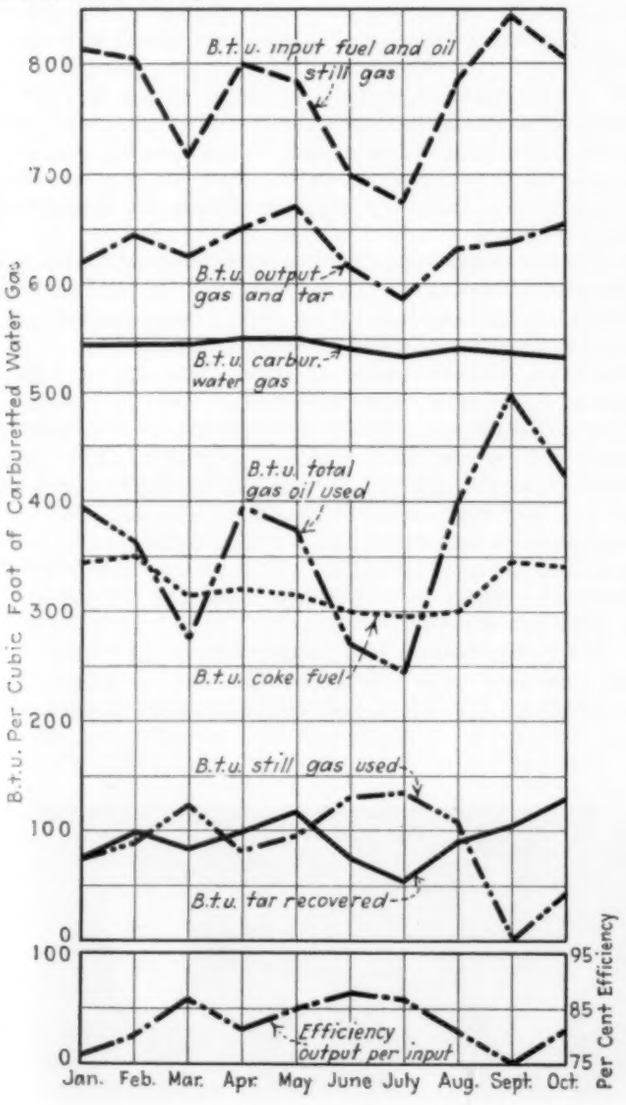
75 to 80 per cent. Greater thermal efficiency, however, does not necessarily mean greater economy. The overall cost after adjustment for byproduct returns determines the economic advantage, and hence the desirability.

Chicago has produced within the past year larger quantities of reformed natural gas than ever before manufactured in the Middle West. A summary of the experience in this production at the Chicago Byproduct Coke Co. plant with natural gas brought 950 mi. from Texas was presented by H. J. Wiedenbeck. The table on page 298 is of particular interest because it summarizes the results over the entire period of operation from June 20, 1933 to March 12, 1934.

With the material improvement in precision of water-gas operation that has come as a result of fully mechanicalized generators, it is now possible to get reliable operating data of technical significance. This fact inspired the investigation of Prof. Alfred H. White, conducted by P. J. Merkus and other assistants, who undertook to evaluate oils on a basis of their composition.

Seasonal Variation in Fuel Usage

Heat input as coke, gas oil, and refinery still-gas contrasted with output in tar and gas of Boston Consolidated Gas Co. when making water gas with coke fuel, using both carburetting-oil and cold still-gas enrichment. Separate curve below shows variation in efficiency.



White and Merkus define available hydrogen content of a gas-making oil as the hydrogen percentage above that necessary to combine with oxygen for the formation of water. From their investigations they conclude that this chemical characteristic of the gas oil can be correlated in practical works experience as a measure of the usefulness of the oil. From their results they draw the following conclusions:

The percentage of available hydrogen in a gas oil has been shown to bear a close relation to its carburetting value. Results are presented for three groups of gas oils which had been tested in the laboratory cracking units of the three companies furnishing them. These carburetting values are correlated with the percentage of hydrogen and the results for the 19 oils varying in specific gravity from 0.8163 to 1.0377 fall, with one exception, fairly well on a curve whose trend is indicated by the following numerical values:

Per cent of available hydrogen in oil	*Pounds of oil required for 1000 cu.ft. of 530 B.t.u. gas*
14.0	14.0
12.0	19.6
10.0	28.0
9.5	33.0

These data indicate that gas oil with 14.0 per cent hydrogen is worth twice as much per pound as one with 10.0 per cent hydrogen and that the carburetting value of oils with less than 10 per cent hydrogen falls off very rapidly when the hydrogen is below 9 per cent. Since modern coal and water gas tars contain only about 5 per cent, and low temperature tars only 6 to 8 per cent of hydrogen it appears that their carburetting value will be negligible.

When bituminous coal is used as generator fuel instead of coke, less oil is required to produce a gas of desired heating value. Results of plant tests of 16 oils show a good correlation with the hydrogen content and the curve does show a smaller amount of oil is required. The slope of the curve indicates that heavy oils may be used more advantageously with bituminous coals than with coke, but the data are not complete enough to do more than make this as a suggestion, which has some theoretical as well as experimental justification.

This correlation of available hydrogen content with the carburetting value of gas oils seems to hold with a wide variety of oils and to deserve a more careful study.

Extensive use of wear-resistant materials is proving an economic advantage in many works. An extended summary of the experience of engineers in this direction was presented at the Conference by Charles L. Locke of Chicago. This matter will later be presented at length in *Chem. & Met.* as a separate article.

Dustproofing of coke for customer convenience investigated by H. J. Meredith of Koppers Gas and Coke Co. shows a definite possibility but as yet no ideal answer. Solutions of deliquescent salts, such as calcium chloride, afford definite disadvantages in the lowering of the fusion point of the ash and causing excessive corrosion of coke-handling equipment, truck bodies, and the smoke pipes of customers' furnaces. All the classes of oils used in emulsion form have the disadvantage of producing smoky coke. This is noticeable when fresh fuel is added to the fire, though usually not serious if the furnace draft is proper. Some novel materials, such as waste sulphide liquor and mixtures of salt, soda ash, and glycerine, have been tried.

Submerged Combustion Attacks Difficult Heating

THE LOW EFFICIENCY of the early steam generating plant gave birth to the idea that complete utilization of the heat of combustion could be secured if the combustion were carried out in such a way as to be completely surrounded by water. The introduction of the flame beneath the surface of the water, submerged combustion, was a radical idea in 1887 and drew many jeers from the popular press. Oscar Brunler, working from 1887 until 1914, perfected his equipment to burn oil beneath the surface of the water. His first installation was made in a chemical plant for the evaporation of sodium tungstate solution, however, this was destroyed during the War. His work has been carried on by his son, who has experimentally applied the equipment to evaporation problems.

Gaseous fuels are more readily used for submerged combustion equipment. C. F. Hammond, in England, has developed a burner to which fuel gas and air stoichiometric quantities are supplied through separate lines under pressure, normally 5 lb. per sq. in. The gases are perfectly mixed at the top of the burner and pass into an insulated combustion chamber which may be submerged to any depth in the liquid. The hot products of combustion bubble upward through the liquid. The commercial burners are constructed in sizes to deliver from 30,000 to 1,000,000 B.t.u. per hr. (See Kobe and Hauge, *Power*, Vol. 77, p. 402-3, 1933, for structural details of the Brunler and Hammond burners.) Fig. 3 shows a Hammond burner in the circulator unit. Liquid enters at the bottom, comes into contact with the hot products of combustion and is raised by air lift action through the opening at the top of the unit; thus positive circulation is maintained in the unit. In the background of this figure is seen a hot water boiler of thermal rating 375,000 B.t.u. per hr., equivalent to the Hammond burner.

A more simple type of submerged combustion burner for gaseous fuel is the Kemp burner. Gas and air are mixed in an industrial carburetor in the proper ratio for complete combustion, or with excess gas or air so that a reducing or oxidizing atmosphere can be maintained. A special alloy burner for heating corrosive liquids is shown in Fig. 2. The gas-air mixture passes down the burner tube, through a grill of refractory material at the top of the ignition chamber, ignition occurs and the burning gas passes through the side openings out into the liquid. The alloy burner is connected by a flange to a $\frac{3}{4}$ in. pipe and will supply from 30,000 to 38,000 B.t.u. per hr., depending on the kind of gas used for fuel.

The higher cost of fuel used is immediately offset by the extremely high efficiencies obtained in submerged combustion. A Hammond heating system reports an

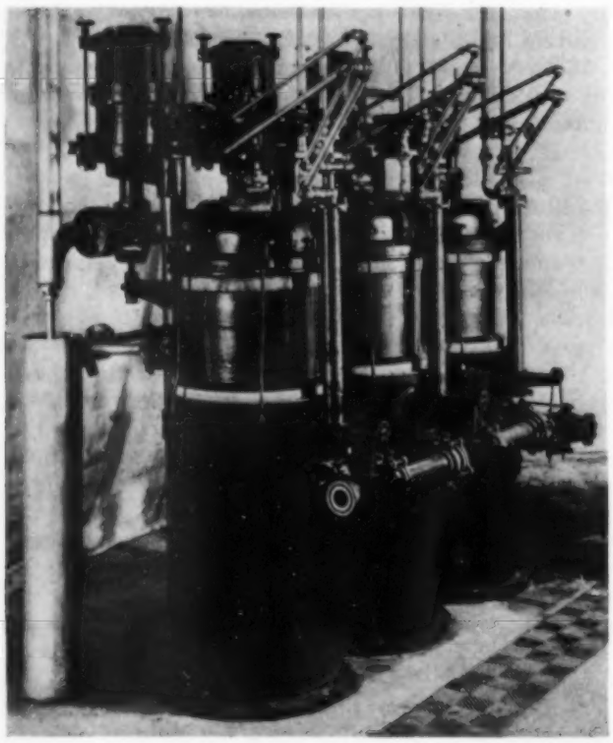


Fig. 1 — Hammond submerged combustion concentrator battery of three units in series. All contact parts in heat and corrosion resisting stoneware. Capacity 240 lb. water evaporated per hour.

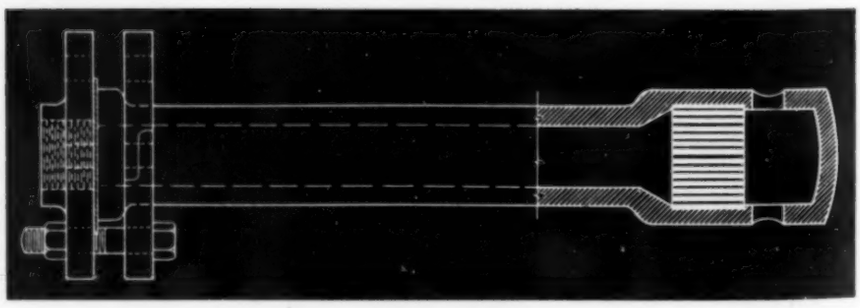


Fig. 2 — Kemp burner constructed of alloy, used for heating corrosive solutions.

and Evaporating Problems

By KENNETH A. KOBE
Department of Chemical Engineering
University of Washington, Seattle, Wash.

efficiency of 94.6 per cent of the gross heating value or 105.8 per cent of the net heating value of the fuel. Such efficiencies are due to the rapid transfer of heat from the hot products of combustion to the liquid. The gas is separated into an extremely large number of minute bubbles. One cubic foot of gas when broken into bubbles one-thousandth of an inch in diameter presents 72,000 sq. ft. of surface through which heat is rapidly transfered to give thermal equilibrium. The gases leave at the same temperature as the liquid so that little heat is lost in flue gases. The condensation of part of the water formed in combustion allows this latent heat to be used, thus the net heating value of the fuel is exceeded when the burner is used to heat a liquid.

The products of combustion leave the solution saturated with water vapor, thus the vapor pressure of the solution controls the quantity of water vapor carried away. As the vapor pressure of the solution never equals the total pressure because of the gases, the evaporation of liquid will take place at a pressure less than the total pressure. Thus submerged combustion evaporation is the equivalent of evaporation under reduced pressure, just as in the case of a steam distillation. Under atmospheric pressure water is evaporated by submerged combustion at a temperature of about 90 deg. C.

Mechanical stirring devices are unnecessary as the rise of the gas bubbles through the liquid produces vigorous agitation. The Hammond circulation system causes the circulation of large bodies of liquid so that a uniform temperature is maintained throughout the liquid.

Corrosion in submerged combustion apparatus can be controlled more easily than in other types of heat transfer equipment. In the usual type there is a large metal surface through which heat must be transfered. As this metal is at a temperature above that of the body of the corrosive liquid the corrosion will be relatively severe. In submerged combustion the heat transfer is from gas to liquid. The containing vessel does not transfer heat so it is at the same temperature as the liquid. It is subjected to little thermal stress so it may be constructed of stoneware, or if of metal, its life is much longer than if it were a heat transfer medium. The burner is the only part of the submerged combustion apparatus which is at a temperature above that of the solution. The burner being relatively small, it may be constructed of the most resistant materials at a comparatively low cost.

When the solution of a salt with an inverted solubility curve is heated, scale formation occurs on the heat transfer interface because the salt is less soluble in the hotter film of liquid next to the interface. With heat transfer through a metal the solid scale (as $CaSO_4$ and Na_2SO_4) builds up on the surface, forming a layer of insulation which decreases the heat transfer coefficient. Periodically the equipment must be shut down and the scale removed to bring the equipment back to its original efficiency. With submerged combustion, heat transfer takes place from the gas to the liquid obviation this difficulty, for the crystals after forming can only settle to the bottom of the container where they remain as a non-adherent sludge.

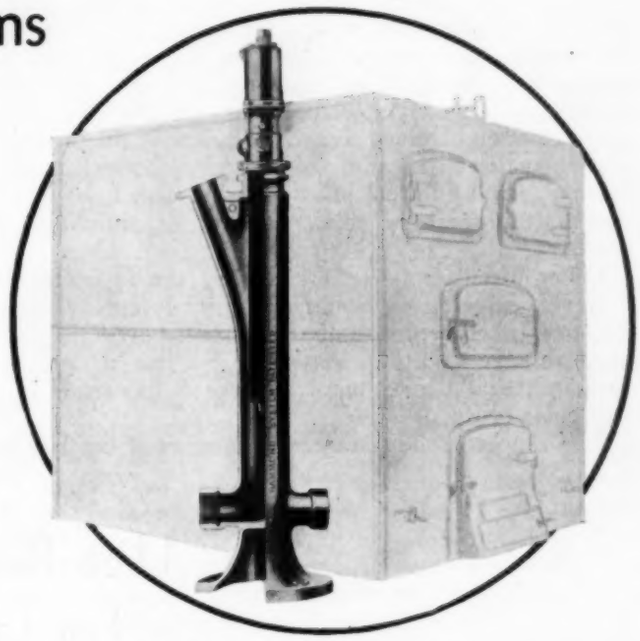


Fig. 3—Hammond burner in circulation chamber. Hot water boiler of equal thermal capacity in background.

The great difficulty in the concentration of phosphoric acid is due to the rapid corrosion of common materials in contact with the hot acid. Hammond has developed a submerged combustion evaporator which successfully resists the corrosive acid. Fig. 1 shows a battery of 3 units in series, capable of evaporating 240 lb. of water per hr. It is seen that the body of the unit is made of a resistant stoneware. The burner is made of a special alloy to withstand corrosion. Only the burner tip is at a temperature above that of the body of the solution so corrosion is not as severe at other points as in an evaporator body where tubes are at a higher temperature due to heat transfer. Loss of P_2O_5 by fume is low, being well below one per cent.

Submerged combustion has proved its advantages when heating chemical solutions. When heating soda ash solutions for removal of oil and grease from metal parts, submerged combustion burners give a desirable agitation in addition to their high thermal efficiency. In acid pickling baths the burners show advantages over the use of live steam or steam coils. At the Federal-Mogul plant

a Kemp burner is used to heat a pickling bath which has a concentration of 24 per cent hydrochloric acid. However, due to the gaseous products of combustion, a temperature of 170 deg. F. is the maximum obtainable in the pickling tank. Hammond has developed special equipment for the electroplating and the dyeing industries. In the former, the absence of dilution and minimizing of corrosion products in acid plating baths are desirable features of submerged combustion. In the dye kettle the circulation obtained and the presence of the products of combustion give results at 180 deg. F. which exceed those obtained by usual practice at 212 deg. F. at which temperature there is greater danger of shrinkage of goods.

Other installations in this country are in operation, however, information concerning them is not available. Apparently submerged combustion heating gives the plant an advantage over its competitors, so that it does not care to reveal the technical advance it has made in a particular process.

The numerous advantages of submerged combustion led to experiments at the University of Washington on some of the problems of interest to local industry. The concentration of sulphite waste liquor has been carried out to give a product containing 63 per cent solids. None of the usual evaporator difficulties, as foaming, corrosion, scaling or viscosity troubles, affected the operation which was carried out with thermal efficiency of 94 per cent, the dehydration of natural glauber salt to anhydrous sodium sulphate has been studied. It is possible to operate directly with the solid decahydrate and use no more heat than a triple-effect evaporator operating on solution saturated at 20 deg. C.

Submerged combustion heating merits attention whereever corrosion, viscous solutions or scale formation are problems. The small surface at a high temperature permits the use of special alloys at low cost, the products of combustion produce their own agitation, and scale formation on a gas bubble causes no worry. Submerged combustion equipment is already in use in various plants and demonstrating in practice these numerous advantages.

Urea Resin Varnish For Laminating

By **H. E. STOCKFISCH**
Chemical Engineer
New York, N. Y.

THE clear water white color recommends urea resin because of the possibility of producing articles and products with light colors. Extensive developments in recent years have demonstrated the beauty obtainable in molded products of urea resin, both laminated and non-laminated.

In this article the descriptions of processes are limited to those leading to the production of flat plates of laminated paper base material. The processing is divided into descriptions of the resin, impregnating paper with resin varnish, and hot pressing into plates.

Production of the resin is simple. In one typical process the reaction is conducted in aluminum digestors, either with or without provisions for autoclaving. The digestor must be connected to a vacuum pump so that the excess water may be evaporated under reduced pressure and removed.

The digestor is charged with 300 lb. of urea which is dissolved in 1,200 lb. of commercial grade formaldehyde with about 20 lb. of phthalic anhydride. The contents of the vessel are heated slowly and uniformly to 90 deg. C. with constant stirring under a reflux condenser. Heating is continued at this temperature until the mass becomes a mobile slightly translucent liquid without color. The excess water which is formed and other volatile matter are removed by vacuum evaporation until the mass contains about 55 per cent solids.

The syrup thus formed is removed from the digestor after cooling. It can be stored for as long as six months without harmful effects and can be diluted to 30 per cent solids without danger of separation. The syrup possesses approximately the following properties: density 25/4 deg. C., 1.22; viscosity, absolute, 11 centipoises; solids, 55 per cent and pH value, 7.5.

Variations in the process and in the materials may be made, as for example, some thiourea may be utilized. The syrup can be shipped best in galvanized steel or aluminum lined drums. It is preferable to protect expensive impregnating equipment such as the rolls and submerged gears with a thin coat of chromium.

The purpose of impregnation is to saturate the fibers of a material with a solution of the resin so that after removing the solvent a quantity of solid resin remains. Subsequent heating in hot presses chemically converts the resin to a permanently infusible state. This type of resin is known as thermosetting or heat hardening.

Absorbency is an important characteristic of materials to be impregnated, therefore sizing and other like processes must be avoided since saturation would be retarded. The composition of the paper varies with the type of product into which it will enter; varying mixtures of alpha pulp, rag stocks and cotton linters comprise the essential ingredients. The paper may be supercalendered if designs are to be printed on it, or it may be only calendered, which is the more general practice.

When desirable a paper stock containing a small quantity of a pigment, such as titanium oxide, can be used. This will give opacity to the final product. Urea resins impart translucence to the molded products, a condition which is valuable but not always desirable.

Resins in an organic solvent, such as phenol-formaldehyde in a benzol-alcohol solution, can be used to saturate the paper without any difficulty as far as the paper is concerned. In water solutions of urea resins this is not

possible without modifying the paper, 50 ft. festoon of wide paper would collapse of its own weight. If we consider that the tension rolls on an impregnating machine exert a substantial drag it will be understood that something must be done to increase the strength of the paper without decreasing absorption power. A toughening process has been developed which accomplishes this.

The tower and the tunnel types of impregnating machines have been developed for synthetic resin work. A system of steam pipes and baffle louvres heat and control the flow of a countercurrent of air which dries the saturated materials. Since water is the solvent no recovery is required. An efficient system will recover 85-90 per cent of volatile organic solvent.

Both machines are totally enclosed with sheet steel. They are solidly constructed, and are equipped with completely synchronized gears, rolls, clutches, and guides, for uniform movement of the paper. The speed of the paper may be varied to suit conditions of the process. Airflow and temperature control devices as well as flow control and varnish levelling apparatus furnish additional insurance of quality. As in any other mechanism the mechanical devices mean little or nothing unless intelligent supervision is applied.

The tunnel machines are about 100 ft. long, and the towers are about 50 ft. high. The former produces paper for cores of plates at fairly high speed with resin content approximately 50 per cent. The tower type runs at slower speeds with a succession of dips to produce surface materials with approximately 65 per cent resin. Each dip is followed by drying.

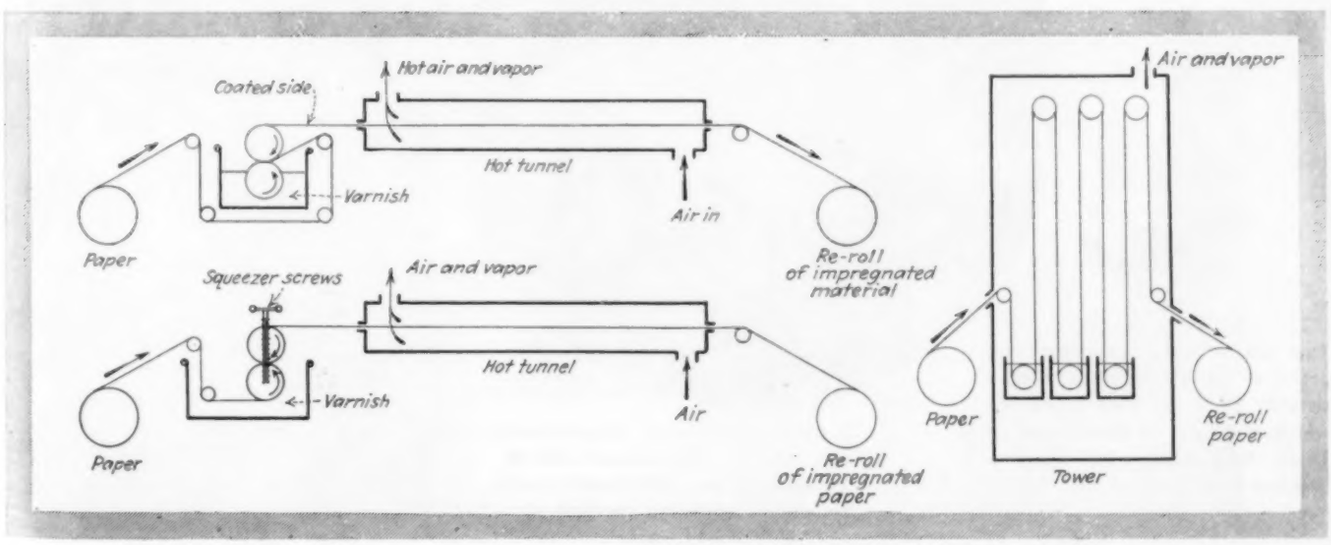
If we wish to impregnate a white paper for core purposes it is threaded through a succession of tension rolls and around the dip rolls and through the tunnel to the re-roller, as shown in an accompanying illustration. The paper passes through the varnish at a speed of 100 in. per min. with the tunnel temperature at 80 deg. C. The accuracy of resin content is controlled mainly by the action of the squeezer rolls which force the varnish into the fibers. The resin content is determined at the issuing end from time to time by cutting out a sample of unit area and determining the gain in weight over an unimpregnated sample of similar size. Certain routine tests must be made to control the fluidity of the resin. These tests are made under conditions identical to those in the molding press.

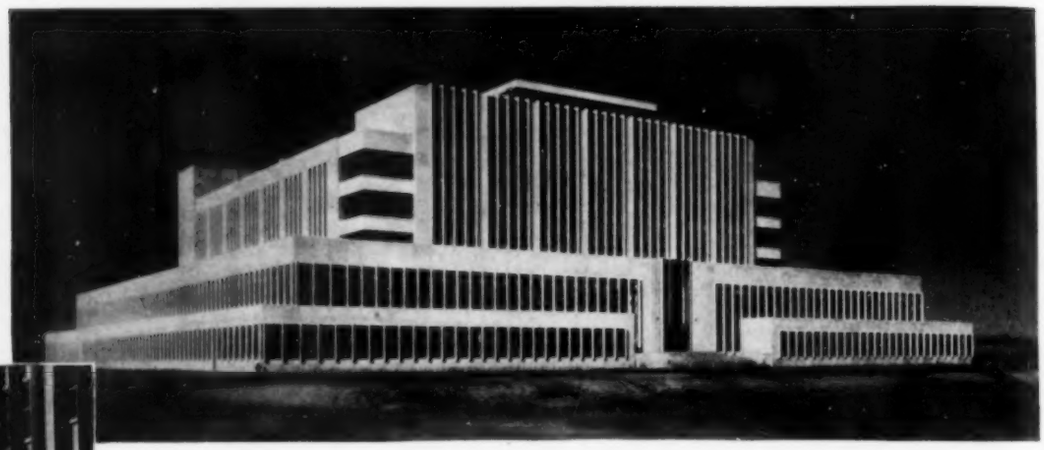
To produce impregnated material for surfaces of plates the colored or other decorative material is threaded through the tower, passing through two dips of varnish of somewhat higher resin content. A speed of 30 in. per min. with the temperature of the tower at 85 deg. C. should be maintained. The issuing material is checked by similar tests. The material must be free of wet areas or drops of thick syrup and as it emerges from the tower should be just dry enough to prevent sticking when rolled. A certain efficiency can be gained by cutting the material into proper lengths on a sheeter as it emerges.

Molding is the conversion of the impregnated papers into products which are permanently hard and decorative. This is accomplished by baking under pressure. To obtain smooth glossy surfaces on plates, metal pressing plates are used, which also act as separating leaves between the molded plates. Stainless steel sheets are suitable for pressing plates. Generally speaking the use of copper has been obsolete since the development of large plates of stainless steel of the 18-8 chromium-nickel type. High luster is obtainable on both sides which is then protected by a film of chromium. The platen press has six or more rolled steel plates superimposed above each other and all heated with steam. After the materials and pressing plates are loaded into the openings of the press sufficient hydraulic pressure should be applied to exert 1,500 lb. per sq. in. on the surface of the material. When the press is closed the steam is passed through the platens and the temperature quickly brought up to 140-145 deg. C. and the material is baked at this temperature for 40 min.

The $\frac{1}{16}$ in. plate is usually sanded on one side and coated with a modified casein cement and while still moist it is veneered to plywood in a veneering press. The material may be veneered to one or to all surfaces. It can be readily understood how universally this material may be applied as the decorative and protective surfaces on all manner of walls and furniture.

Tunnel systems for coating one side and for thoroughly impregnating paper or fabric. Tower system showing succession of dips of material



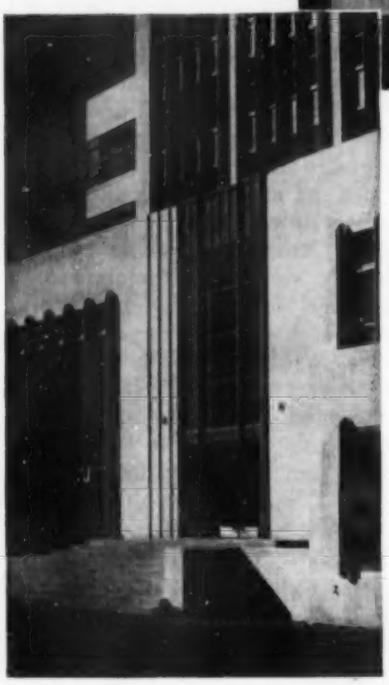


New home of the Forest Products Laboratory at Madison, Wis.

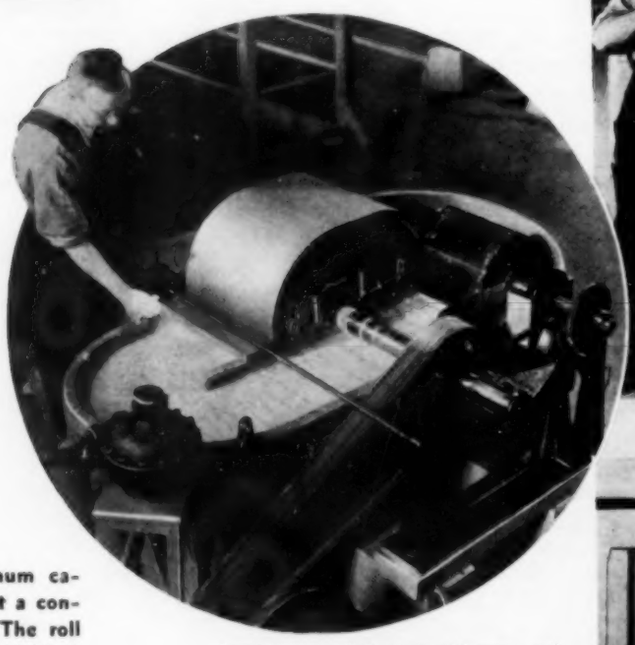
Forest Products Laboratory's

The new building of the Forest Products Laboratory maintained at Madison, Wis., in cooperation with the University of Wisconsin is now being occupied by the staff. The structure is U-shaped, about 275 ft. in length and over-all breadth, and contains five stories and ground floor, a total area of 175,000 sq.ft.

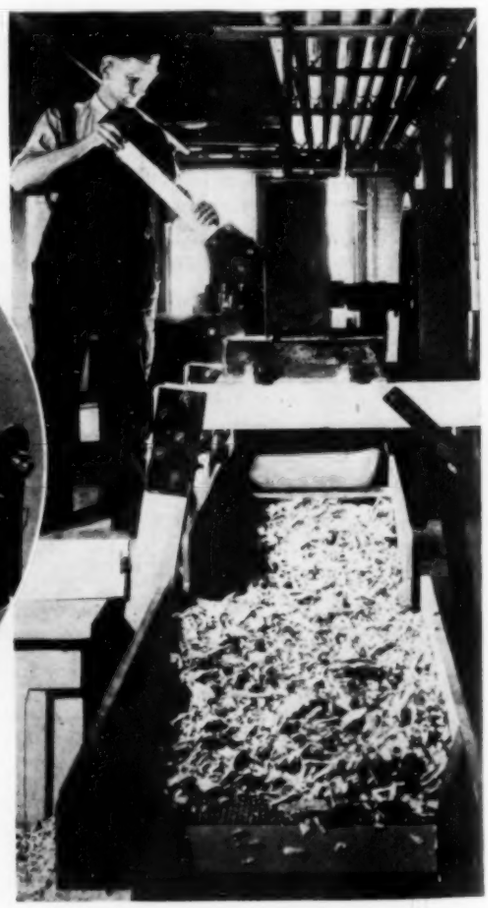
External walls are faced with Bedford limestone, while large areas of glass are an outstanding feature of



Main entrance to the laboratory shows modern features



This beater has a maximum capacity of 60 lb. of pulp at a consistency of 5 per cent. The roll which is 24 in. in diam. with an 18-in. face weighs 900 lb. and rotates at a speed of 300 r.p.m

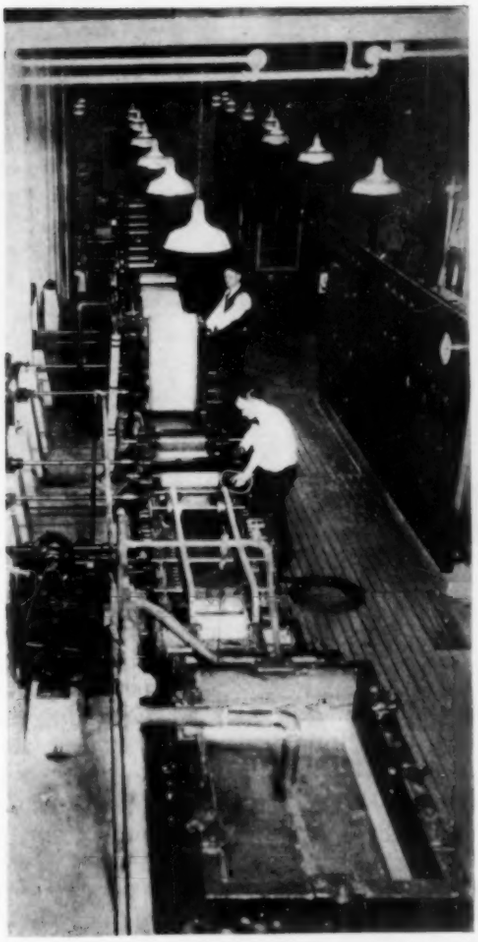


Semicommercial size chipper and drip screen. The chipper disk is 28 in. in diam., fitted with two knives for producing standard size 5/8-in. chips

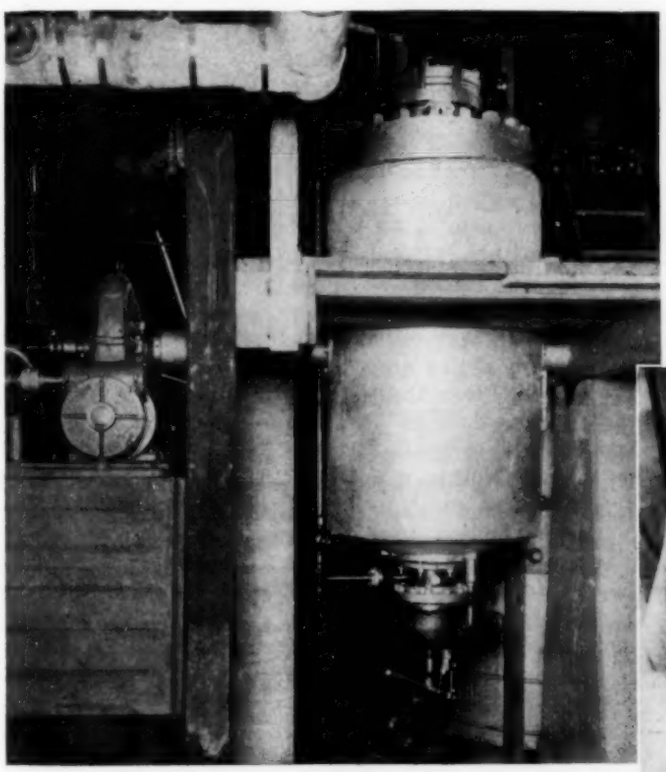
Two-pocket grinder with hydraulic cylinders. The stone is 26 in. in diam. by 11 in. face. Bolts of wood ground are usually 9 in. in length

Modern Facilities

the design. While structurally fireproof, the building is featured by the use of wood to the best advantage. Interior trim, including doors, door frames, and window frames, is predominantly of wood. Softwood trim with paint finish is used for the ground floor and working portions of the first floor. For the second, third, fourth, and fifth floors, the trim is a representative selection of American hardwoods.



The paper machine is equipped with a 16-in. wire, felt presses, dryers and calender stack. It can be operated up to 150 ft. per min.



The 50-lb. rotary digester is made of cast steel. In addition to this digester for pulping by the alkaline processes the laboratory has three ½ cu.ft. cast steel autoclaves, and a horizontal carbon steel rotary cooker of 35 cu.ft. capacity.

The sulphite digester is of 50-lb. capacity and is lined with 23-11 chrome-nickel steel, spot welded to a carbon steel shell. It is jacketed for indirect as well as direct cooking. A 1½ cu.ft. steam-jacketed autoclave with an 18-8 chrome-nickel clad inner shell is also used for experiments.

How to Avoid Difficulties In Cellulose Acetate Production

By HAROLD C. WHITE
Chemical Engineer
Bangor, Me.

IN THE MANUFACTURE of cellulose acetate there are at least three types to consider. First in importance, from the standpoint of consumption, is that used in the manufacture of rayon. Next is the type used in making safety films. The third general type is used in the production of plastics. Each of these varieties requires different characteristics and qualities in the finished product. Each type has a different combined acetic acid content, as well as some variations in other properties.

The cost of a cellulose acetate plant is high, due to the necessarily expensive materials of construction. Much aluminum is used in tanks and pipe lines for handling glacial acetic acid and anhydride. The latter is a fairly expensive raw material, and its cost is the largest item in the total cost of the cellulose acetate. Thus a plant which can produce anhydride by the cheapest process is at a big advantage. Of extreme importance for the profitable operation of a plant of this kind is also an efficient method for acetic acid recovery. The problem is to recover the diluted acetic acid used in the process and to concentrate it to glacial strength, performing this function with an efficiency and at a cost such that little outside acetic acid need be added to the system once it is in operation.

Method of Production

The general procedure used in the manufacture of cellulose acetate is as follows: Cotton, in the form of purified linters, is treated with acetic anhydride, glacial acetic acid and a catalytic agent, usually sulphuric acid. After stopping the first reaction, a hydrolyzing catalytic agent, is added, and the process of reducing the number of acetate groups is carried on. The degree to which these groups are reduced depends on the type of acetate desired. This process is termed "saponification" in the industry. The cellulose acetate is precipitated from its solution in acetic acid by dilution and the excess acetic acid is removed and recovered. The cellulose acetate is thoroughly washed and sometimes treated with a solution of sodium bicarbonate to remove the last traces of acid, whereupon it is dried and ground to the desired fineness.

Factors which affect the final characteristics and quality of cellulose acetate include: the biological characteristics of cotton; the preliminary treatment of the cotton linters; the quantities of catalyic agent; the concentration of the cotton in the glacial acetic acid during acetylation; the temperatures during acetylation and saponification; the time during the several stages of the acetylation operation; delays before precipitation, after stopping saponification; and the use of sodium bicarbonate in stabilizing the product.

Differences in the nature of the soils and variations in climatic conditions produce changes in the physical properties of the cotton, which, in turn, affect the quality of the acetate produced. The preliminary purification of the cotton has much to do with the type of acetate which can be produced from it. If the cotton is drastically bleached, it is impossible to produce a product with sufficiently high viscosity for spinning purposes. This is probably due to degradation of the cellulose molecule during bleaching. It is difficult to procure a continuous, uniform supply of purified linters, even when the utmost care is used in the purification process. Accordingly, it is necessary to keep blends of large size on hand, and to be able to counteract skillfully, by changes in operation, any variations in properties which the cotton linters show. It is important to bear in mind, then, that cotton linters of uniform high quality are the first requirement in the manufacture of cellulose acetate, and when this factor is taken care of, many operating troubles are avoided.

Purified linters are pressed into bales and securely covered with heavy wrapping paper for shipment. When received the bales are unpacked as needed and passed through a picker, the function of which is to loosen up the fibers and "fluff" the cotton so that the chemicals can react more readily with it. Briefly, the picker consists of an apron which acts as a feeder to a heavy cylinder fitted with special teeth. This cylinder revolves between a stationary plate similarly studded with teeth. After passing through the picker the cotton may be dried by heat to about one-half per cent moisture and weighed for the charge, or it may simply be weighed and conveyed to the acetylation process.

Processes are now in vogue which produce approximately a ton of cellulose acetate per charge. All methods of preparing this product are closely covered by patents. The equipment for acetylation may be constructed of copper, and must have some means for thorough agitation of the charge. In addition, a system which provides close temperature control must be a part of the reacting equipment.

It is possible to dry the cotton by using acetic anhy-

dride to convert the moisture present to glacial acetic acid. If this system is used, it is the first step which takes place in the acetylator. After the cotton is charged into the machine, a definite quantity of glacial acetic acid is added and the mixture agitated. A freezing point test of the liquid in the acetylator is then made, and from this the quantity of acetic anhydride required to produce glacial acid may be calculated and added to the charge. Thus the moisture in the cotton is provided for.

The next step is the addition of the catalytic agent. Strong sulphuric acid cannot be added directly to the charge, for it would not only char the cotton, causing discoloration in the finished product, but would not be mixed uniformly enough throughout the charge to keep the reaction going at an even rate. As a result, the sulphuric acid is diluted with a considerable quantity of acetic acid, and is slowly added to the charge. The quantity of sulphuric acid to be added is important, for each type of acetate requires a different quantity, and variations from the correct quantity cause trouble. It is necessary to weigh the catalytic agent carefully, and to be sure that it is of a high grade of purity. C. P. acid is best for this purpose.

It is usual to agitate for some time after the addition of the catalytic agent, so that the charge will become as uniform as possible. At this stage the charge is simply a mixture of cotton, sulphuric acid and glacial acetic acid.

Then by slowly adding acetic anhydride, the cellulose is converted to the acetate. The temperature must be closely regulated, or the reaction may proceed too rapidly and result in too much degradation of the molecule, with a consequent low viscosity. As the cotton dissolves, a sort of gum forms which at first is opaque. When the acetylation nears completion, the gum becomes transparent. A rapid viscosity test may be advantageously used in order to determine the finish at a desired viscosity. The acetylation of large batches requires about three hours.

Variations in concentration of the cotton in the glacial acetic acid are caused by moisture in the cotton and by the strength of the anhydride. Naturally, a high moisture content and an anhydride of a comparatively low strength make the reaction proceed somewhat more slowly, due to the lower concentration of the reacting mixture.

Saponification

When the acetylation has continued far enough for the desired product the reaction must be stopped. This may be done by the addition of a small volume of water, too much will cause precipitation, or by the addition of acetic acid of the proper strength. The latter method is more satisfactory from the standpoint of acid recovery.

The product at this stage in the process approximates a triacetate and for commercial purposes must have its combined acetic acid content reduced to conform with the different type requirements. It is merely a hydrolysis reaction and is catalyzed by the addition of further sulphuric acid. This, as in the first case, must be mixed with acetic acid and must be added slowly. Saponification could be carried out in the same equipment as the acetylation, but it is of advantage to keep charges moving along, and use other equipment for this purpose. A wooden tank with agitator and equipment for temperature control is satisfactory for the process. It is customary to hold the charge to a constant temperature during saponification, so that the approximate time when the charge is finished may be determined. A difference of one degree in temperature makes quite a difference in the time required. For example, on a spinning grade of acetate, the time required at 41 deg. C. is approximately 18 hr., while at 45 deg. C. it is about 12 hr.

As the saponification nears completion, quick plant tests may be made to determine the combined acetic acid content of the acetate. When complete, the reaction is stopped by previously mentioned means.

There should be no extensive delay between the saponification operation and precipitation. If there is a delay, saponification will still proceed slowly and the combined acetic acid content will be too low. The wooden precipitating tank should be equipped with a powerful agitator and a large outlet.

Filtration

After the required volume of water, or weak acid, has been placed in the precipitating tank, the agitator is started and the charge run in as quickly as possible. The batch should not be agitated for too long a time, for the material will become too fine and will not filter well. The acetate is permitted to remain in the tank with an occasional short agitation until the inside of the particles no longer show signs of gum. The acetic acid which is present with the charge at this point should not be over 30 per cent in strength. Stronger acid causes the acetate to be soft and gummy, which results in poor filtration. Acetate used for plastics, with its comparatively low combined acetic acid content and low viscosity, usually precipitates in a powdery form, and is more difficult to filter.

Filtering is done in order to remove most of the excess acid from the charge and to recover it. One scheme is to use a wooden tank with a perforated false bottom which is covered with filter cloth. The acid which is drained off is pumped to the recovery system. An overhead spray of weak acid and water may be used to assist in displacing the stronger acid from the charge. In the case of one type of acid recovery, the cut-off to the recovery is made at a point when the strength of the acid from the filter becomes about one per cent.

It is necessary to remove as much of the free acid from the charge as possible. Accordingly, a thorough final washing is required. The equipment may be similar to that used in the filtering operation, except that no pump is necessary. The wash water, after passing through the charge, simply enters the sewer.

The washing process requires a considerable length of time. Much depends on the physical condition of the charge. If the particles are comparatively large the last traces of acid are removed more easily and the final washing takes from 24 to 36 hr.

The removal of some water by centrifuging or pressing is of advantage. The material may then be ground to the desired degree of fineness in any of the several types of fine grinders, and fed to the final dryer. The drying may be carried out in a batch type of dryer, but it is probably advantageous to use a continuous moving pan type. The moisture content is usually reduced to less than five per cent, and then the acetate is ready for any of its several uses.

Developments in Heat Transfer With Organic Compounds

By R. LYMAN HEINDEL, Jr.
The Dow Chemical Co.
Midland, Mich.

INDIRECT HEATING has been accomplished by steam, hot gases, oils, a number of organic compounds and mercury. Saturated steam has a practical and economical upper temperature limit in the neighborhood of 450 deg. F., which corresponds to a pressure of approximately 400 lb. per sq.in. At temperatures in excess of 450 deg. it is generally desirable to employ other heat transfer materials.

Where temperatures above 750 deg. are encountered in the system, and it is desired to heat by means of a vapor, mercury is today the logical material to use. Although mercury costs in the neighborhood of $100 per gallon, it is an element, and in the absence of oxidizing conditions, is capable of operation at temperatures several hundred degrees higher than any known organic compound. The gap remaining between the practical range of high pressure steam and the point where mercury vapor must be used is bridged by organic fluids.

Some of the organic heating materials which have been proposed during the last few years are anthracene, phenanthrene, naphthalene, diphenyl, diphenyloxide, certain specially selected oils and a series of mixtures under the name of Dowtherm. Each of these materials has certain advantages and certain disadvantages which we will briefly consider.

For a number of years, certain oils have been used as heat transfer fluids. These materials are limited in practical applications to temperatures below 600 deg. F. They frequently flow sluggishly, leaving a sludge or carbon-like deposit on heat exchange surfaces. The over-all efficiency of such a fluid system is low. Such oils may be purchased for approximately 80 cents a gallon.

Anthracene and phenanthrene have never been seriously considered because they are not commercially available in sufficient quantities. Published thermal data on phenanthrene were obtained from especially prepared laboratory samples.

Naphthalene is a definite compound, having the formula $C_{10}H_8$ and a melting point of 176 deg. F. Although it boils at 423 deg. F., the most serious objection to its use is its tendency to sublime. Naphthalene is quite cheap, selling from 5 to 8 cents per pound, depending upon the quality and quantity.

Several years ago Dr. H. H. Dow (*Mech. Eng.*, Vol. 48, 1926, p. 815) proposed the use of diphenyloxide in bi-fluid power plants. For other applications of diphenyloxide see *Power*, Vol. 73, 1931, p. 963; *Combustion*, Vol. 3, 1931, p. 38; *Steam Eng.*, Vol. 1, 1932, pp. 476, 495; *Mech. Eng.*, Vol. 55, 1933, p. 369. This material has the formula $(C_6H_5)_2O$. It has a melting point of 80 deg. F. and boils at 496 deg. F.

Diphenyl, $C_{12}H_{10}$, was developed commercially even more recently than diphenyloxide. Diphenyl has a melting point of 154 deg. F., and a boiling point of 491 deg. F. (See *Ind. Eng. Chem.*, Vol. 22, 1930, p. 700; Trans. A.I.Ch.E., Vol. 24, 1930, p. 56; *Power*, Vol. 72, 1930, p. 374; *Ind. Eng. Chem.*, Vol. 23, 1931, p. 763; Mich. Univ. Eng. Res. Bulletin, Vol. 23, 1932, pp. 1-78.)

It is quite obvious that with equivalent boiling points and with corresponding vapor temperature ranges, the most desirable materials for use as transfer agents are those which remain liquid at room temperature. It is our belief that at the present time the most practical heat transfer medium for operation in the range of 450 to 750 deg. F. is the eutectic mixture of diphenyloxide with diphenyl, known as Dowtherm A.

Mixtures of diphenyloxide and diphenyl composed of as much as 37 per cent of the latter are characterized by melting points lower in all cases than either diphenyloxide or diphenyl alone. The minimum freezing point (53.6 deg. F.) is obtained with 73.5 per cent of diphenyloxide and 26.5 per cent of diphenyl. Dowtherm pipes do not have to be steam-jacketed, as the material will not crystallize at room temperature, as will diphenyl and other single compounds.

A similar eutectic mixture of diphenyloxide and naphthalene composed of approximately 85 per cent of the former and 15 per cent of the latter, and having a freezing point of 61 deg. F., is designated as Dowtherm B. The boiling range of Dowtherm B is wider than that of Dowtherm A, and the freezing point, as will be observed, is somewhat higher.

Dowtherms A and B, in common with diphenyl and diphenyloxide, sell at a price between 16 and 20 cents per pound, depending upon the quantity. Their use, and exceptional properties which make them desirable for such use, will be described in the following portions of this paper.

If circulating liquids are desired which do not have the sludging characteristics found in oil, it is recommended that Dowtherm C, a very high boiling material capable of application up to 800 deg. F., be employed. If a non-flammable agent for liquid-phase heat transfer is desired at temperatures not to exceed 650 deg. F., it is recommended that Dowtherm D be used. For the purposes of this paper, however, we will restrict ourselves to the discussion of Dowtherm A.

Condensed from a paper presented by the author under the title of "Industrial Developments in Heat Transfer With Organic Compounds," before the New York meeting of the A.I.Ch.E., May 15, 1934.

In all the time that diphenyloxide has been produced, there has been no evidence of any injurious effect from inhaling its vapors. In liquid or crystalline form it is entirely without the irritant or corrosive action of phenol and has no injurious effect whatever on the skin. If it should accidentally get into the mouth or eye, Dowtherm produces a slight burning sensation for a short time, somewhat similar to the effect of kerosene, but beyond that it shows no harmful results.

The possibility of combustion is another hazard which exists in the use of organic heat transfer materials. Dowtherm will burn, especially at elevated temperatures. Good engineering practice in its use calls for equipment with all welded joints, or at least with sufficiently tight joints to eliminate losses. If losses occur through small leaks in the system and if a source of ignition is present, the vapors will burn as though coming from a jet, and will not have any tendency to explode. In case of a leak in the furnace compartment, the high percentage of carbon dioxide would prevent the occurrence of an explosion. Fig. 1 defines the explosive limits of Dowtherm A, carbon dioxide and air. It will be observed from this chart that the hazard is particularly small. In the boiler unit the gas temperature will usually be in excess of the upper explosive limit of Dowtherm A, so that escaping vapors may ignite, but cannot explode.

In regard to stability, experiments have been conducted on both laboratory and plant scale to determine

Fig. 1—Explosive limits at atmospheric pressure of Dowtherm A, air and CO_2
(Accuracy limits of data, 10 per cent)

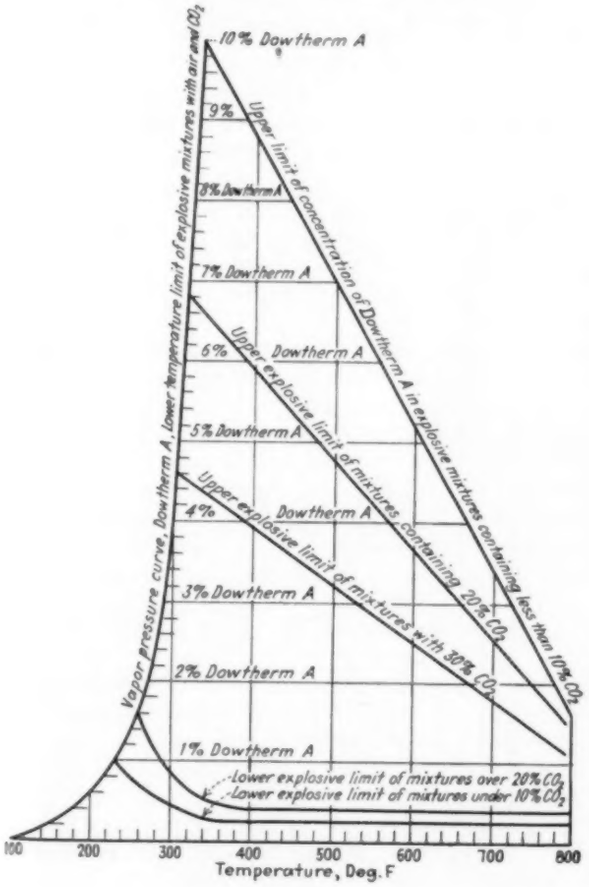


Table I—Thermal Decomposition of Dowtherm A and B in Presence of Air

Temperature, Deg. F.	Decomposition Per Month, 20 Working Days of 24 Hours Each, Per Cent
650	0.25— 0.35
700	0.4 — 0.6
725	1.1 — 1.6
750	approx. 3.3 — 5.0
775	approx. 7.0 —10.0

Table II—Period of Service With Dowtherm Before Purification

Maximum Temperature in System, Deg. F.	Time, Months
650	45—60
700	25—37
725	10—14
750	3— 4
775	1½— 2

the life of Dowtherm under extreme conditions of temperature and pressure. The most serious operating condition for Dowtherm is that in which there is an oxidizing agent or an excess of oxygen. It was under such a condition that the tests in Table I were made. The Bremo Station has operated for three years with a Dowtherm temperature of 650 deg. and with less than 2 per cent breakdown of Dowtherm in the three years.

In the customary Dowtherm application where temperature is being carefully controlled through the regulation of pressure, the accumulation of decomposition products or of polymers having even lower vapor pressures than Dowtherm will materially affect the accuracy of such pressure-temperature regulations. Laboratory tests, confirmed by actual plant experience, point to the fact that when the accumulation of polymerization products reaches 15 per cent the Dowtherm should be removed from the system and purified. At the breakdown rate indicated in Table I, 15 per cent concentration of undesirable materials would not accumulate until approximately the time indicated in Table II had elapsed.

The temperatures indicated in all cases in the table are to be taken as the maximum temperature at any point in the Dowtherm system. The recommended maximum vapor temperature is 735 to 740 deg. F. This means a top temperature of 750 to 760 deg. at any point in the system.

Removing Decomposition Products

When it becomes necessary to purify the Dowtherm, owing to the accumulation of decomposition products, as will occur when operating above 700 deg., two methods may be employed. These include distillation and/or crystallization.

Where the available equipment is satisfactory, distillation is probably the more effective. The Dowtherm may be boiled in the regular Dowtherm boiler, the vapors passing up through the heat exchanger where they are condensed, and then returned by gravity to a separate tank for cleaned, recovered material. Purification by crystallization uses simpler equipment, but at the same time requires a little more handling. The material is drawn from the boiler into crystallizing pans which are suitably cooled below 54 deg. F. Crystals of Dowtherm appear around the sides of the container and a liquid residue remains. This may be separated from the crystals either by filtration, or preferably, by decantation,

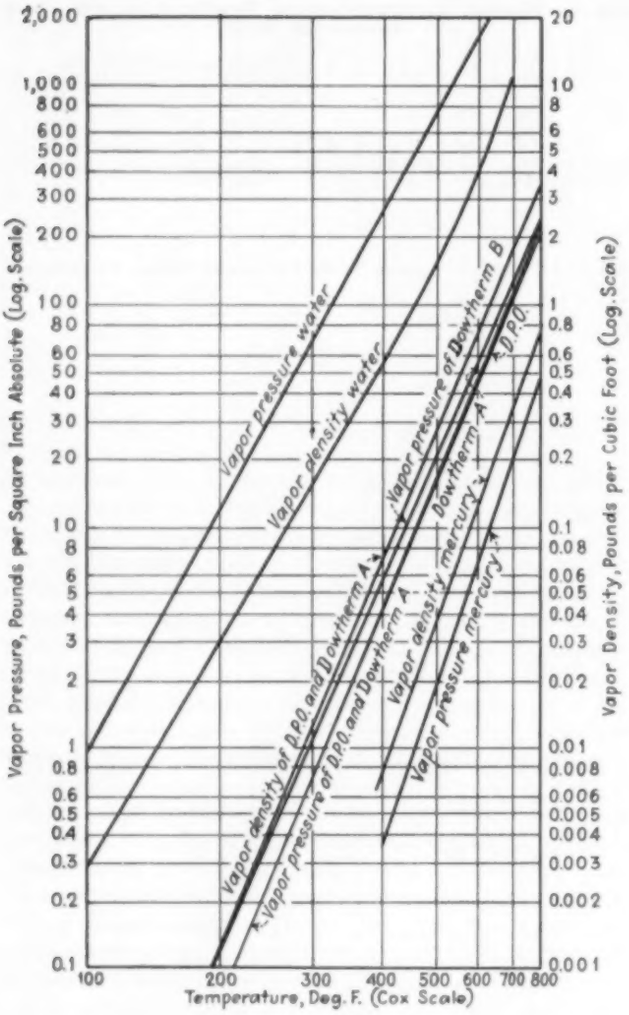

Vapor Pressure, Pounds per Square Inch Absolute (Log. Scale)
Vapor Density, Pounds per Cubic Foot (Log. Scale)
Temperature, Deg. F. (Cox Scale)
Vapor pressure water
Vapor density water
Vapor pressure of Dowtherm B
Vapor density of D.P.O. and Dowtherm A
Vapor pressure of D.P.O. and Dowtherm A
Vapor density mercury
Vapor pressure mercury
Dowtherm A
D.P.O.

Fig. 2—Vapor pressures and vapor densities of Dowtherm, water and mercury

and the crystals may then be brought to room temperature and the liquid stored. The filtrate or supernatant liquid is recrystallized several times until a product of satisfactory purity no longer separates.

To make understandable the properties of Dowtherm, it is frequently desired to compare these properties with those of water. Table III makes these comparisons and Figs. 2 and 3 give additional data.

Table III shows steam to be nearly eight times as effective a heat carrier as Dowtherm at the boiling point. When it is remembered, however, that Dowtherm boils at nearly 500 deg. and that the pressure required to deliver steam at 500 deg. will amount to several hundred pounds, the advantage of Dowtherm becomes more apparent.

Table III—Physical Properties of Dowtherm A Compared With Water

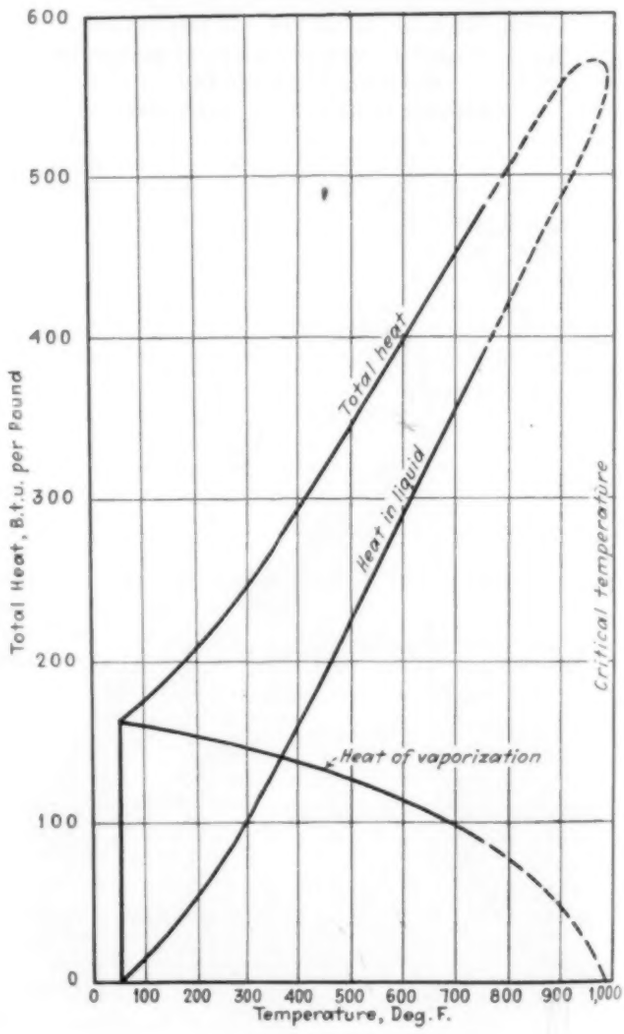
	Water	Dowtherm A
Specific gravity at 212 deg. F.	0.9584	0.9950
Relative densities of saturated vapors (not corrected for temperature)		
Ratio to water at atmospheric pressure	1	7.5
Ratio to water at 50 lb. abs. pressure	1	8.95
Ratio to water at 100 lb. abs. pressure	1	7.3
Melting point, deg. F.	32.0	53.6
Boiling point, deg. F.	212.0	500
Specific heat of liquid at respective boiling points (B.t.u. per lb.)	1.005	0.63
Heat of Vaporization at respective boiling points (B.t.u. per lb.)	970.2	123
Cubical expansion coefficient (32-212 deg. F.) per deg. F.	0.00024	0.00045
Absolute viscosity of liquid at 212 deg. F. (Centipoises)	0.284	1.0

Dowtherm in Power Generation

The first large scale application of Dowtherm to production of power was in the plant of the Virginia Public Service Corp. in Bremo Bluff. In this plant the Dowtherm was used in an economizer in the stack, the heat absorbed in this economizer section being released in the air preheater. Another interesting but as yet only partially tried application of Dowtherm is its use as a heat storage medium. Power plants are subject to varying loads. The excess heat which is generated during the off-peak period can be absorbed in suitable equipment and furnished in readily available form during the peak-load demand. Steam accumulators have long been used for relatively rapid fluctuations in the load, particularly in small power plants, but they do not permit the storage of heat at a sufficiently high temperature to provide superheated steam at full boiler pressure.

A heat absorber similar to that used for air preheating may be located in the stack to absorb excess heat from flue gases, transferring it into large storage tanks

Fig. 3—Heat content of Dowtherm A



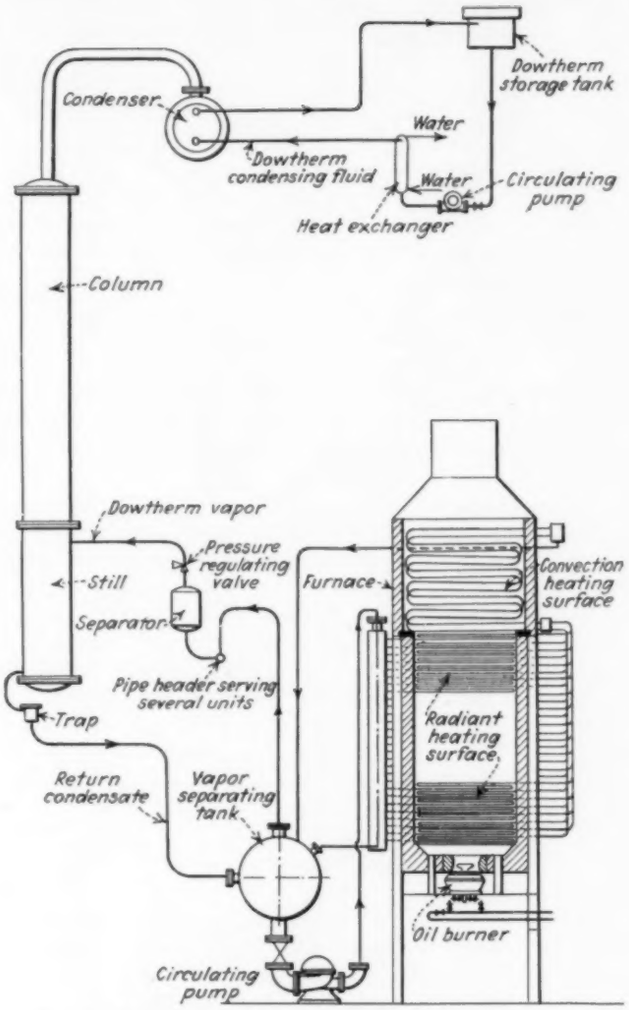


Fig. 4—Dowtherm boiler and condenser unit in actual commercial operation

continuously at a slow rate and then drawing on this heat reservoir to make steam or preheat the boiler feed water at times of demand. To overcome the low specific heat of Dowtherm the heat storage tank may be filled with a heavy material such as scrap or pig iron bars or other heavy metal ingots. The heat which is absorbed by the Dowtherm will be transferred to this heavy heat storage material in the tank. The heat obtained from such a storage system would be available at very low cost, since it would be heat which is now being lost through high temperature stack gases. At present the heat available in stack gases frequently exceeds the amount of heat required for preheating secondary air by as much as 30 to 50 per cent.

Dowtherm in Process Industry

Although a wide variety of applications of Dowtherm has been proposed for heating and cooling operations, there has been to date a rather limited number of such applications in large-scale commercial operation. When Dowtherm is being considered as the means of conveying heat to or from an object, the first decision to be made is whether the transfer shall be effected by means of vapor or circulating liquid. In case of cooling operations, the liquid form will be simpler of operation and more efficient. An exception would be the rare case where it is desired, for example, to cool a reactor from 750 to 600 deg. without the application of pressure. In such a case vapor of Dowtherm A at 500 deg. can be used, but liquid Dowtherm C would be more desirable.

In heating operations it is usually necessary to have a temperature head of 30-50 deg. when using the liquid, and only 10-15 deg. when Dowtherm vapor is used. At temperatures below 500 deg. it is probably desirable to use Dowtherm in the liquid form, unless a constant subatmospheric pressure can be advantageously maintained.

As an example of the advantage of heating by means of condensing vapor as compared with circulating liquids, let us take a case where it is desired to transfer 50,000 B.t.u. per minute to the wall of the heat exchanger at 500 deg. F. in a system in which the circulating pump has 2-in. inlet and outlet connections. The temperature should not fall below 500 deg. F.

A. Liquid circulation, with a temperature head of 30 deg.
Heat in liquid at 530 deg. F. = 240 B.t.u./lb.
Heat in liquid at 500 deg. F. = 222 B.t.u./lb.
Difference, in dropping from 530 to 500 deg. F. = 18 B.t.u./lb.
To transfer 50,000 B.t.u./min. requires 50,000/18 = 2,777 lb. = 390 gal./min.
Circulation is through 2-in. pipe, having capacity 0.174 gal./lin.ft., or 42.9 lin.ft./cu.ft.
Length of pipe to hold 390 gal. = 390/0.174 = 2,240 ft.
That is, circulation must be at the rate of 2,240 ft. per min.
Circulation through pump = 2240/60 = 37.4 ft. per second.

B. Vapor condensation.
Total heat at 515 deg. F. = 352 B.t.u./lb.
Heat in liquid at 500 deg. F. = 222 B.t.u./lb.
Difference = 130 B.t.u./lb.
To transfer 50,000 B.t.u. requires 50,000/130 = 384 lb. = 53.2 gal. liquid at 500 deg.
This is only 13.5 per cent as much Dowtherm as needed in liquid form.
Feed to Dowtherm boiler in vapor system = 0.138 × 37.4 = 5.2 ft. per second.

Many chemical materials must be manufactured and purified under conditions which do not permit of solidification in distilling apparatus. In such cases it is required to maintain the condenser at a temperature between the boiling point and the freezing point of the distillate. Dowtherm is being successfully applied in the manufacture of a product of this nature in our own plant. (See Fig. 4.) In this particular application the Dowtherm is heated with steam from nearby process equipment. It is then circulated through the tubular condenser at a temperature slightly in excess of the freezing point but considerably below the boiling point of the material being distilled.

The use of Dowtherm as a cooling agent is equally as important in many cases as its function as a heating material. It is much more successful as a cooling agent than the oils which have been used for this purpose.

An installation in which it is proposed to use Dowtherm as the cooling agent is of interest to those manufacturers who are troubled with exothermic reactions. In one such reaction it is desired to maintain the temperature at all times below 400 deg. F. There is ordinarily a stage in the reaction at which a sudden evolution of heat occurs. At this stage it is desired to remove the excess heat by circulation of Dowtherm through coils immersed in the reaction vessel. The Dowtherm enters at approximately 200 deg. F. and after leaving the reactor at 300 deg. F., it is allowed to circulate through

a pipe coil radiator system which dissipates the heat to the atmosphere. The radiator may be of the fin type so that the system can operate on a minimum amount of the circulating liquid.

The Dow Chemical Co. has an oil-fired, "straight-through" boiler unit for generating Dowtherm vapors which operates without preheated air and generates from 2,500,000 to 4,000,000 B.t.u. per hour (*Power*, Vol. 76, 1932, p. 202). This boiler operates at an over-all efficiency in the neighborhood of 60 to 65 per cent. The furnace and boiler unit are constructed entirely of steel, without refractory material in the wall of the furnace itself. (See Fig. 4.) Forced circulation of the liquid Dowtherm permits location of the vapor drum below the boiler, so that the entire boiler will drain back into it during the shut-down periods. The Dowtherm vapor is carried away from the drum at a pressure of 50 lb., directly into the walls of the reactor and distilling unit which are being heated. The hot condensate from the jacketed still is returned to the expansion tank of the system through a heat exchange unit which serves to preheat raw material being fed to the continuous still.

The boiler feed of Dowtherm liquid is maintained by means of a centrifugal circulating pump at a rate of 600 g.p.m. or approximately 3 ft. per second. The circulating pump has a cast-steel casing and a forged, nitrided-steel shaft. It is good practice to use such equipment, as cast-iron housings are frequently too porous. Likewise, cast-iron moving parts do not stand up under temperatures such as are met in a Dowtherm vapor system.

We have found that any valve which is satisfactory for operation with oil at given temperature will prove satisfactory with Dowtherm at the same temperature, providing that it has a deep stuffing gland. The most satisfactory level-gage is a flat sight-box of the type known commercially as Mica Sight. An ordinary all-steel pressure gage (without coil siphon) is attached above the expansion tank. Two 4-in. safety valves on the drum are set to open at 100 lb. The fuel oil pump is provided with a pressure-actuated electrical cutout and is interlocked with the Dowtherm circulating pump.

A similar installation in satisfactory operation in another factory operates at a higher temperature than any other Dowtherm system in successful operation at the present time. The boiler is a steel-cased boiler of the forced-flow recirculation type, supplying Dowtherm vapor at 144 lb. pressure. This corresponds to a vapor temperature of nearly 760 deg. and probably means that a temperature of 775 deg. is attained in some of the radiant portions of the system.

The fact that these two units are of the all-steel type does not indicate that a brick-set furnace would be impractical. There are commercially available brick-set furnaces with recirculation Dowtherm boilers of small capacities which are particularly adapted to small industrial applications. These are especially applicable where low head-room is available between the floor and the bottom of the vessel to be heated. In such cases brick-set furnaces can be arranged to generate Dowtherm vapor for effective heating, and at a very economical figure.

One application of Dowtherm, which is the subject of a British patent issued in 1930 (B.P. 336,369), is in the processing of liquid hydrocarbons, particularly in the cracking of crude oil. The advantages claimed for this system are that the cracking is carried out under carefully controlled temperature and pressure conditions instead of in a direct-fired furnace. Since the Dowtherm pump may be working at high temperature, this patent suggests the use of a cooling gland on the shaft driving the pump. This gland is said to be cooled by circulation of Dowtherm at a temperature of about 80 deg. and at a pressure slightly higher than that in the Dowtherm system, so that any leaks through the pump are of cooled Dowtherm inward from the gland. It has been our experience that the gland is not necessarily cooled, but if a fairly tight-fitting steel shaft is used in a centrifugal pump and if a very deep stuffing box is added, losses are reduced to a minimum.

Following are a number of possible applications of Dowtherm to several process industries: Industrial heating of factories and buildings; the heating of jacketed reactors and kettles for candy making and for chemical reactions; evaporators; vacuum pans and crystallizing pans; the curing and vulcanizing of rubber; the heating and cooling of rolls such as used in the manufacture of glass; the heating of platen presses for molded products; the heating of rubber molds for vulcanizing and similar operations; the heating and cooling of soap reactors; and for the production of hot water or steam. Dowtherm may be used for melting zinc for hot-dip galvanizing and the melting of type metal for linotypes. Tin-plating and similar operations can profit from Dowtherm applications. Lead-cable-sheath presses may be advantageously heated with Dowtherm.

Thermal Coefficients

The heat transfer coefficient from condensing Dowtherm vapors to dry steam has been found to be in the range from 45 to 57 B.t.u. per sq.ft. per hr. per deg. F. total temperature difference. Dry gases are poor heat carriers, as are viscous liquids. These figures agree very favorably with data published by McCabe on the transfer from condensing diphenyl vapors to asphalt through the walls of standard 1-in. pipe (*vide supra*, Mich. Univ. Eng. Res. Bul.).

The film coefficient of Dowtherm A has been found to be in the range between 230 and 380 B.t.u. per sq.ft. per hr. per deg. F. at Dowtherm velocities from 5 to 9 ft. per second.

In one large scale experimental unit the Dowtherm vapor entered the condenser at a temperature of 600 deg. and left at a temperature near 300 deg. in the form of liquid condensate. The over-all transfer coefficient from condensing vapor to water in this case was found to be 75 B.t.u. per sq.ft. per hr. per deg. F. total temperature difference. In another case Dowtherm vapor was used to preheat an organic compound prior to distillation. The organic material entered the preheater at a temperature of approximately 300 deg. F. and was heated by Dowtherm vapor which entered the heat exchanger at 600 deg. and left at 580 deg. The coefficient of heat transfer from condensing vapor to the organic liquid was 62 B.t.u. per sq.ft. per hr. per deg. F. In general, our experience leads us to expect over-all heat transfer coefficients from Dowtherm vapor to steam or to various organic compounds in the range 45 to 90 B.t.u. per sq.ft. per hr. per deg. F. total temperature difference.

Mercury Vapor as Applied to Process Industries

By CHARLES A. HULSART
The Babcock & Wilcox Co.
New York, N. Y.

USE OF MERCURY vapor as a medium for the transfer of heat is neither new nor untried. The first commercial applications to chemical processes, so far as we know, were made in 1915, in connection with the distillation of beta naphthol and the sulphonation of naphthalene. Since that time there have been installed 19, or more, mercury units, of which the best known are those being used by the Sun Oil Co., Philadelphia, Pa., for the distillation of lubricating oils. Along with the investigation and development of mercury vapor as applied to chemical processes, considerable advances were made in the field of power generation, until today there are three large mercury-steam-electric units in commercial use.

The advantages of saturated vapors over direct-flame, hot-liquid, or hot-gas methods of heating is evidenced by the general use of saturated vapors when the temperature range is within their limits. Engineers have long appreciated the fact that in the vapor stage the temperature of a saturated vapor medium remains constant and only the latent heat of the vapor is utilized in the heating or cooling process. With mercury vapor added to this class of heat-transfer media, the temperature range of vapor heating is materially increased. As a matter of fact, the only temperature limitation of mercury, in so far as the heating medium is concerned, is the upper temperature limit of the metals used for heat-transfer equipment.

If we assume that a pressure of 6 lb. per sq.in. abs. is the practical minimum for each of the principal media used for vapor generation—water, the diphenyl group, and mercury—there is a temperature range for steam from 170 deg. F. at 6 lb. to 636 deg. at 2,000 lb.; for the diphenyl liquids from 425 deg. at 6 lb. to 735 deg. at 136 lb.; and, for mercury, from 591 deg. at 6 lb. to 1,000 deg. F. at 180 lb. (For vapor pressure curves for these media see p. 310, this issue.—Ed.) However, with the mercury vapor process, by use of the "puff" system, the lower limit of temperature may be reduced to somewhat less than 350 deg. F. Mercury is used in the lower limits only in cases where exact control of temperatures and simplicity of equipment are essential, as these temperatures are within the temperature range of either steam or the diphenyl liquids.

Mercury has in its favor, as a medium of heat transfer, the following particular advantages over other liquids:

1. The required temperature is obtained with a considerably lower pressure.
2. Mercury is an element and, therefore, has no tendency to dissociate or form compounds by rearrangement of its atoms.
3. It is not a solvent for, neither does it form amalgams with, steel. There is, therefore, no tendency to foul the heating surfaces, nor to change the quality or quantity of the heat-transfer medium in the system. (It does have, in both the liquid and vapor states, a scrubbing action on the steel surfaces and, although all surfaces coming in contact with mercury should be sand blasted or pickled before assembly of the unit, the mercury will find and clean off all particles of mill or welding scale and any other foreign matter which may be present. This requires that provision be made, in the design of the apparatus, for removing this material until such time as the system is clean. This will be accomplished in several weeks of operation, after which the system may be sealed and operated over long periods.)
4. Mercury solidifies at —38 deg. F., which, for all practical purposes, eliminates the freezing hazard.
5. The high specific gravity of the liquid makes it possible to return condensate to the boiler by gravity, with the headroom available in most of the existing process buildings, thus eliminating the necessity for pumping equipment of any kind.
6. Mercury and its vapor are non-flammable, and are, therefore, practically suited to chemical processes in which the material being heated is combustible or explosive in the presence of flame.

Other advantages include low cost of attendance, low maintenance, and the small space required for installation. Any source of heat can be used with mercury systems, such as oil, gas, coal, or electricity.

It is not the intent of the foregoing to give the impression that the mercury process is the magic wand of heat transfer work, or that it is so far superior to other methods that it alone should be considered, for such is not the case. There are, and will continue to be, many cases of application where other liquids are more economical and the question as to which medium is the most economical should be decided on its merits after all engineering and economic factors have been given due consideration.

An erroneous impression prevails so generally regarding the dangers of mercury poisoning that it is desirable to state briefly the facts of the matter. The Babcock & Wilcox Co. gave this question very serious consideration when it first commenced its extensive work on mercury

Condensed from a paper presented by the author before the New York meeting of the A.I.Ch.E., May 15, 1934.

boilers, about 1924. At that time, an exhaustive investigation into this subject was made. Leading authorities in the medical and manufacturing fields were consulted and the experience of the General Electric Co. with mercury over a period of several years prior to that time was taken into account.

This investigation proved conclusively that there is no need to fear mercury poisoning, in fact in all of the experimental work carried on by General Electric and The Babcock & Wilcox Co. with mercury vapor apparatus no one engaged in this work has experienced even a moderate case of poisoning.

It is commonly believed that mercury vapor is colorless and tasteless, and while this may be strictly true of the vapor in very minute quantities, such as would be given off by ordinary evaporation from a container standing in a room, a vapor leak from a system under pressure is readily visible in the form of a dense gray cloud attended by a silvery deposit caused by condensation on adjacent cool structures. Anyone exposed to such a leak is decidedly aware, almost immediately, of a brassy taste in the mouth and discomfort in the throat.

Such a leak will, of course, occur only in systems operating above atmospheric pressure. In a great many industrial heat-transfer units, the mercury vapor will be used at pressures less than atmospheric. Any leak, therefore, would be of air into the system, rather than of mercury vapor outward.

Mercury Leaks Give Ample Warning

It must be remembered that in many industrial plants the operators are accustomed to handling poisons that are considerably more dangerous than mercury or mercury vapor. Mercury vapor, if in sufficient volume to cause serious effects, produces so much discomfort to the person exposed to it that he has ample warning of its presence. If the mercury vapor is not in sufficient volume to be tasted, seen or smelled, it soon produces a severe headache and thus gives ample warning that it is present. If exposure is continued, the headache is followed by distress in the alimentary canal, such as an extreme looseness or constipation; if either of these distresses are experienced, the person would, in a properly operated plant, be certain to seek immediate relief.

In central stations, the maximum precautionary measures are taken, but these, at the most, are really the simple principles of hygiene, most of which should be practiced even if there were no mercury in the vicinity. As a matter of fact, the physical condition of operators of mercury equipment has actually been found to be considerably above that of the average operator, because of the habits of cleanliness that are required of workers by the employer.

In general, the following simple precautions are observed in central stations where large volumes of mercury are used:

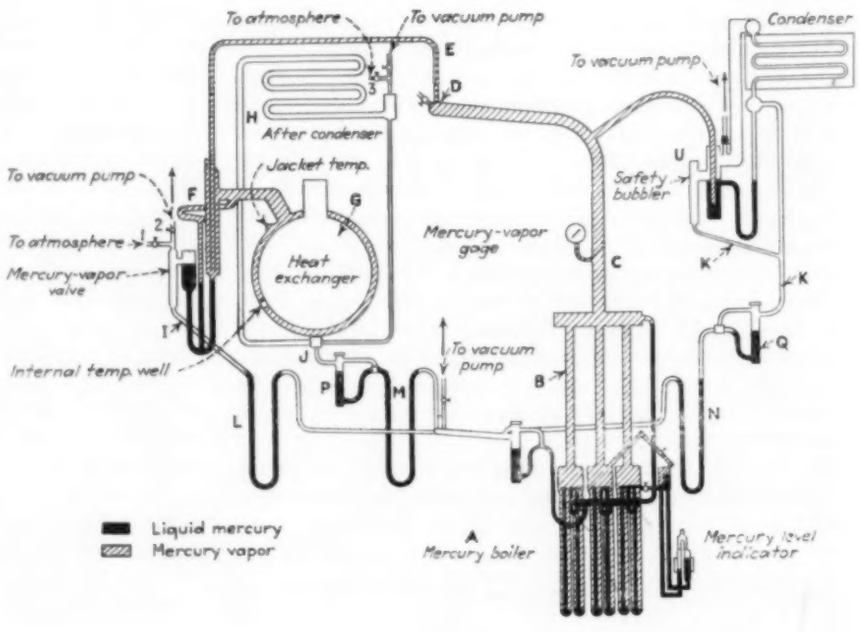
1. Men are given a medical examination prior to being associated with mercury; those susceptible are thus eliminated at the start. Frequent examinations of operators are made to keep a check on their condition.
2. Operators bathe and change clothing completely before leaving the plant. Work clothes and street clothes are kept separate. Clean work clothes are provided by the management.
3. No smoking is allowed in the boiler room, and tobacco is used elsewhere only after the face and hands have been washed.
4. No food is kept or eaten in the boiler room. Before eating each workman must wash his face and hands and brush his teeth.
5. Potassium chlorate mouth-wash is provided.
6. Boiler room, turbine room, etc., are kept scrupulously clean and well ventilated.
7. When handling liquid mercury, rubber gloves are worn under the regular work gloves.
8. Blower-type masks are provided for use when working inside any apparatus.

In this connection, it will be of interest to note that a mercury detector developed to a high state by the General Electric Co. will take continuous samples of flue gases or air in the room, with a sensitivity of one part of mercury in several millions.

The equipment for process heating by mercury vapor may be divided into three classes:

1. In which the vapor temperature is obtained at pressures below atmospheric pressure.
2. In which the temperature is in a range of pressures from atmospheric pressure up to approximately 30 lb. gage.
3. In which the temperature is above approximately 30 lb. gage.

Fig. 1.—Typical mercury vapor heating system for operation at sub-atmospheric pressure in heat exchanger



Each of these three classes requires a separate method of control.

In Class (1) the control is provided by utilizing air at atmospheric pressure and vacuum to control the passage of mercury vapor to the heat exchanger. In Class (2) the temperature is controlled by providing an artificial atmospheric pressure, the use of which, with vacuum, controls the passage of mercury vapor to the heat exchanger. Class (3) is simply the conventional type of control for pressure vapor heating.

The application of Class (2) is limited by the cost of the liquid mercury in the barometric leg of the mercury vapor control valve only.

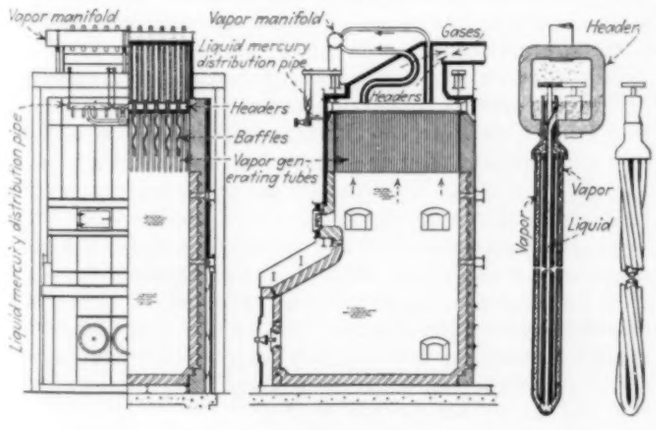
A typical installation of mercury vapor heating as for Class (1) is shown by Fig. 1.

It will be noted in this figure that *A* is the mercury boiler, in which the headers from the sections of the boiler are joined together by connecting tubes, *B*, in a single main header, *C*, which branches off at *D* into a number of service headers, one of which is indicated by *E*. Each of these is connected through the valve *F* to a heat absorbing or mercury-vapor condensing unit, *G*. Vapor after-condenser *H* is provided, connected as shown. Return lines *I*, *J*, and *K*, from the mercury vapor valve, the heat exchanger, and the safety bubbler, lead to traps *L*, *M*, and *N*, and cleanouts *P*, *Q*, and *R*.

The safety bubbler, *U*, is merely a safety valve, and differs from the ordinary steam safety valve in that it does not open to the atmosphere, but opens instead into a closed condenser, with provision for returning the condensate to the boiler by gravity. It also differs from the usual steam safety valve in that the specific gravity of the liquid is so great that no mechanical parts, such as valve springs or valve seats, are necessary. A barometric leg of liquid mercury replaces the valve seat and disk of the conventional type of safety valve.

The control of the temperature in the heat exchanger is accomplished through the mercury vapor control valve, the purpose of which is three-fold: First, to permit shutting off the mercury at will from the heat exchanger, and to permit the entrance of the mercury vapor whenever desired; second, to permit the operation of the heat exchanger at a low pressure without endangering the operation of the boiler; and third, to control the mercury vapor without in any way presenting a metallic surface other than liquid mercury as a valve seat.

Fig. 2—At left, typical B. & W. mercury boiler; at right, B. & W. mercury-vapor-generating tube in detail



The mercury vapor control valve is operated by the difference in pressure between the atmosphere and the lesser pressure within the unit; that is, the column of liquid mercury in the mercury control valve is regulated by raising and lowering the mercury level by intermittent exposures to atmospheric pressure. By the raising and lowering of the level of the liquid, the supply line through which the mercury vapor is passed to the heat exchanger is opened and closed.

By this method of control, there are none of the usual conventional types of valves exposed to mercury and, consequently, there is no maintenance of valves or valve seats.

A further unique feature of this system is the possibility of operation of the boiler at a comparatively high mercury vapor pressure on the heat exchanger in such manner that during the heating-up period the full benefit of this higher pressure is obtained in the jacket of the heat exchanger, so as to cause quick heating. Following that, the required temperature is maintained in the heat exchanger, corresponding to a very much lower mercury vapor pressure, by what may be termed the "puff" system. In this method, the valve is alternately opened and closed, to permit at each operation the injection of a small quantity of mercury vapor at higher pressure. This mercury vapor expands suddenly, producing the low pressures and low temperatures required in the heat exchanger.

How the "Puff" System Works

Briefly, the operation of the "puff" system is accomplished through manipulation of valve (1) (to atmosphere) and valve (2) (to vacuum). Assuming the unit on the line, and mercury vapor passing to the heat exchanger, as the temperature approaches the upper limit, valve (2) is open and valve (1), to the atmosphere, is closed, thus putting a vacuum on the reservoir side of the mercury vapor control valve.

To stop the flow of mercury vapor to the heat exchanger, valve (2) to the vacuum pump is closed, and valve (1) to the atmosphere is opened. The in-rushing air at atmospheric pressure replaces the vacuum, which drops the liquid mercury in the reservoir, and this liquid mercury then flows into the lower chamber of the vapor valve, submerging the lower end of the vapor supply pipe in liquid mercury and thus stopping the flow of vapor to the heat exchanger.

As the heat in the mercury vapor surrounding the heat exchanger is absorbed, the temperature drops, and, when the temperature reaches the lower temperature range of operation, the passage of more vapor mercury to the heat exchanger is accomplished by closing valve (1) to the atmosphere and opening valve (2) to the vacuum. This evacuates the air on the reservoir side of the valve, thus withdrawing the liquid mercury from the vapor side of the valve, and exposing the lower end of the vapor pipe to the source of mercury vapor, and mercury vapor again flows to the heat exchanger.

In the foregoing description of the operation of the unit, it might be assumed that the valves were hand operated, whereas, in actual service, this is accomplished by automatic controls, which operate on temperature, and these controls may be made either by regulating the flow of mercury vapor by the temperature of the material in

the heat exchanger or by the temperature of the mercury vapor surrounding the vessel.

In addition to the automatic controls for the passage of vapor to the vessel, there is usually provided an automatic control for the fuel burner. This control operates from the pressure or temperature of the mercury vapor in the vapor main adjacent to the boiler, which automatically controls the amount of fuel burned, in accordance with the requirements of the heat exchanging equipment.

In Fig. 1 but one heat exchanger is shown, for purposes of illustration, but multiples of heat exchangers may be taken from the same vapor main. Each heat exchanging unit would be complete with its own mercury control valve, after-condenser and automatic controls.

The after-condenser performs several functions.

1. With the "puff" system, the after-condenser provides an additional amount of heating surface available in order that the temperature in the mercury vapor heating element may be uniformly distributed. It will be found in practice that the mercury vapor will actually rise to a given point in the after-condenser, and this point may frequently be used, in lieu of a thermometer, to ascertain the operating temperature inside the heat exchanger.

2. The second important function of the after-condenser is to collect the air remaining in the system after evacuation and to vent it. Before placing the unit in operation, it is evacuated to approximately 0.2 millimeter upon starting. However, due to the high temperature of the mercury vapor even this small amount of gas remaining after evacuation rises to a considerable vapor pressure relative to the low pressure of the mercury vapor, and may produce difficulty if some provision is not made for collecting this remaining gas.

3. The third function of the after-condenser is to act as a protector to the vacuum pump, in order that under no conditions can mercury vapor be carried to it, even though the heating surface of the heat exchanger be completely bathed in the mercury vapor.

On the lower end of the after-condenser there is installed manually-operated valve (3), to the atmosphere. This valve is for emergency use, in the event that for any reason it is desired to eliminate the mercury vapor in the heat exchanger. This is accomplished by opening the valve which permits air to enter and displace the vacuum, thus causing rapid condensation of the mercury vapor and stopping the boiling of the liquid mercury in the system. This, of course, is only for emergency operation, as it is important that as little air as possible should enter the system, as oxygen combines with both mercury and steel to form oxides that would have a tendency to foul the system.

The returns for the liquid mercury are equipped with traps and sumps. The sumps permit the removal of mill scale and sludge, that are carried through the system in suspension, and should be cleaned out frequently, when the equipment is first put into operation; it will be found, however, that the amount of mill scale and other foreign material obtainable from the sumps will diminish to the minimum within a few weeks, after which the necessity for further cleaning will be infrequent.

The design and operation of mercury vapor equipment for the second class, where an artificial atmosphere at about 30 lb. is provided to replace air at atmospheric pressure, is similar to that described for Class (1). For the third class, where the temperature range is over 30 lb. gage, the design and operation of the unit is similar to either steam or high-boiling point liquid systems other than mercury; that is, the unit is designed to work at a positive pressure, and control is maintained through valves and the safety valve exhausts taken care of through safety valves of the conventional design but modified, as necessary, for mercury vapor service. In addition, because of the value of the mercury, closed condensing equipment is provided on the safety valve exhaust to conserve any mercury passing through.

Due to the high specific gravity of liquid mercury and due also to the fact that liquid mercury does not ordinarily wet steel, it is necessary to provide a boiler of special design for this service.

There have been certain theories on using other metals, such as sodium, for forming an alloy with liquid mercury for the purpose of wetting the surfaces in the boiler, and thereby obtaining higher rates of heat transfer.

Mercury Boiler Design

A typical mercury boiler is shown at the left in Fig. 2, and consists of horizontal headers into which are inserted mercury-vapor-generating elements. These elements extend downward into the hot gases of the furnace, and each contains its own system of circulation. The design of the mercury-vapor-generating tubes is shown at the right in the figure.

In the design of a mercury vapor heating unit, all material that comes in contact with mercury must be made of steel, or, for extremely high temperatures, special steel alloy, for the reason that, of all our structural metals, steel alone is not subject to attack by mercury, except in very insignificant degree.

The question as to whether or not mercury wets the surfaces of a mercury boiler is somewhat controversial. It is known that if steel is cut in a bath of liquid mercury, the surfaces will be wetted. However, as it is impracticable to manufacture commercial equipment by any such method, all design is on the assumption that the mercury does not wet the surfaces of steel, and all formulas for heat transfer have been based on this principle and checked by actual tests.

The cost of the liquid mercury is often mentioned as an argument against its use. This is not justified for the reasons, first, that the amount of liquid mercury required is small; second, that there is practically zero deterioration; and third, that mercury is always resaleable at practically the market price, which means that the only loss chargeable to the use of liquid mercury in a system is the interest charge on its initial cost.

In addition to the use of mercury vapor in the transfer of heat to process material, mercury has also been used as a cooling medium for exothermic reactions, as well as in a combination requiring, first, heating, and then cooling. The cooling is accomplished by providing in the heat exchanger a reservoir of liquid mercury so that, when the temperature of the material reaches its maximum, and it is desired to cool it, the mercury vapor is shut off and the liquid mercury allowed to boil, thus absorbing either the residual heat or the heat caused by chemical reaction, the mercury vapor being condensed and returned to the boiler by gravity or returned to the heat exchanger for further cooling.

ELECTROCHEMICAL DEVELOPMENTS REPORTED

MANY of the recent electrochemical developments were discussed at the Asheville meeting of the Electrochemical Society in April. Some of these were reported on page 274 of the May issue of *Chem. & Met.*, others are briefly mentioned below.

All day Saturday was devoted to electrochemical papers. W. W. Stender, P. B. Zivotinsky and M. M. Stroganoff reported at length on tests made on the Vorce cell. The paper on the electrochemistry of germanium, by J. Ivan Hall and A. E. Koenig, was illustrated with interesting samples. Other papers were on: hydrogen overvoltages of iron-chromium alloys by M. deKay Thompson and D. M. Fleming of M.I.T.; a new metallized glass quinhydrone electrode by E. Newberry of Cape Town.

The potential of the cobalt electrode was measured by M. M. Haring and B. B. Westfall at the University of Maryland. They find that the normal potential is close to—0.300 volt.

An electrochemical meeting without a discussion on corrosion is well-nigh impossible. Accordingly the paper by C. W. Borgmann and Ulick R. Evans of Cambridge, presented by Dr. F. N. Speller, elicited considerable comment from H. S. Lukens, Frary, Fink, Johnston, Blum and others. The authors had investigated the corrosion of zinc in chloride solutions. Their results provide little hope of materially increasing the resistance of zinc to any of the liquids studied by eliminating or adding other metals, by protecting the cut edges or by avoiding abrasion of a rolled surface. A. D. Garrison and J. F. Lilly of Rice Institute, discovered the existence of a rather close relation between oxygen overvoltage and catalysis. D. F. Calhane and A. J. Laliberte of Worcester Polytechnic Institute found that columbium did not give the familiar rectifying effect of tantalum.

An outstanding development in electro-organic chemistry is the use of concentrated aqueous solutions of the sodium salts of aromatic sulphonates as solvents for various organic compounds. R. H. McKee and Joe R. Heard, Jr., of Columbia presented two papers on this topic, the first on the stability of the sulphonate solvents and the oxidation of benzaldehyde and benzyl alcohol. The electrolytic oxidation of benzaldehyde to benzoic acid was carried out in the presence of a copper oxide catalyst at a nickel anode with high-anode gas absorption efficiency and without tar formation under alkaline conditions. Certain catalysts, notably cobalt and nickel hydroxides, were found to greatly increase the rate of oxidation of benzyl alcohol at a nickel anode to form benzaldehyde and benzoic acid. The relative amounts of benzaldehyde and benzoic acid in the oxidation products may be varied with the alkaline pH of the solution.

The second McKee-Heard paper dealt with toluene, oleic acid and benzoin. Toluene, naphthalene, anthracene and borneol are not oxidized in alkaline solutions. Oleic acid was oxidized with a higher anode gas absorption efficiency in alkaline solution than under slightly acid conditions, while with the linseed fatty acids, the reverse was found true. Under strongly acid solutions, toluene and the solvents are oxidized to phenolic compounds. Naphthalene depolarized a graphite anode in a strongly acid solution with the formation of quinone and phenol products. Benzoin was oxidized to benzoic acid under alkaline conditions at higher current efficiencies than previously reported.

R. D. Blue and F. C. Mathers displayed a large number of interesting samples of aluminum deposited from a bath composed of 30 gr. Al in 1 c.c. of Br, 450 c.c. of ethyl bromide and 250 c.c. of benzene; current density 0.9 amp per dm.^{2}, 3 volts. The plated aluminum adheres well to Pt, Cu, Fe and cast iron, but not to Al or to Mg.

▼ ▼ ▼

HEAT TRANSFER BY RADIATION

By H. C. HOTTEL

Associate Professor of Fuel Engineering
Massachusetts Institute of Technology
Cambridge, Mass.

Editor's Note—This is the last of the series of articles on heat transfer initiated in our issue of May, 1934.

IN THE field of high temperature heat transfer where radiation becomes an important and sometimes a controlling factor, the chemical engineer has been somewhat slow to adapt to his needs the available basic knowledge of the physicist. Although the concept of separating overall resistance into its components is familiar to the designer of low temperature heat transfer equipment, the analogous concept of separating the heat transferred in a furnace into its components due to radiation from the gases, from the refractory walls, from the luminous flame, etc., is much less common among furnace designers. Figures on overall performance continue to be used in design calculations.

The relative dearth of data on heat transmission at high temperature levels is undoubtedly due in part to the special technique necessary, and to the need for tools less familiar to the chemical engineer than those used in studies of conduction and convection. The familiar tools for measurement of heat flow, such as a flowmeter and thermometers in combination, must be replaced by the bolometer or thermopile. The measurement of true temperature, particularly of a gas, becomes increasingly difficult as the temperature level increases. At flame temperatures the thermocouple becomes useless, and the optical pyrometer is of little value if used in the ordinary way unless the flame is substantially "black," which is seldom true.

Another factor contributing to the incompleteness of our knowledge of radiant heat transmission is the common misconception of the use and meaning of Kirchoff's law of equality of emissivity and absorptivity, a misconception which has tended to make the engineer content with inadequate data. The law is valid only for a system in equilibrium, i.e., for one in which there is no net heat interchange. Contrary to the general belief among engineers, we are dependent on experiment for a determination of how nearly the absorptivity of a body approaches its emissivity under conditions in which there is heat interchange between the body and its surroundings.

The separation of the total radiant heat transmission into the various mechanisms involved should bring to the designer of high temperature heat transfer equipment the same advantage which the film concept, replacing the concept of overall coefficient, brought to the designer of moderate temperature equipment, namely the ability to predict performance of many combinations by a study of a relatively small number of basic types.

A balance sheet is given on page 318 showing the approximate status of our knowledge in the field of radiant heat transmission.

Balance Sheet for
HEAT TRANSFER BY RADIATION

ASSETS	LIABILITIES
Radiation Between Solids	
Solution of various geometrical problems of effect of orientation of surfaces has been obtained and simplified for engineering use.	Such solutions involve assumption of cosine principle, whereas the effect of angle of emission on radiation is not known for most surfaces.
Emissivities of a great variety of surfaces have been determined.	Emissivity of a surface is so dependent on its history as to make exact calculations impossible at present.
Emissivity of highly polished pure metals has been correlated with their electrical conductivity.	Effects of roughness on emissivity are somewhat conflicting.
Problems of allowing for successive reflections, arising in cases of interchange between surfaces of high reflectivity, have been solved for some cases.	Only the simpler problems have been treated, and by the approximate method of assuming surfaces "gray". Problem of radiant heat interchange in an enclosure of many faces still unsolved.
Radiation from Non-Luminous Flames and Gases	
Method is available for determination of radiation from gases by the use of measurements, at room temperature, of their absorption spectra; and such spectra are available for many gases of importance in heat transfer problems.	Such a method involves the questionable assumption that the absorption coefficient of the gas is independent of gas temperature. Direct measurement of gas emission is much to be preferred.
In addition, measurements of total radiation from water vapor are available.	Similar measurements are desirable for carbon dioxide,[1] sulphur dioxide, ammonia, methane, etc.
Effect of gas shape on radiation interchange with its bounding surface is known for a number of industrial shapes.	Many shapes remain to be studied.
Distinction between chemiluminescent radiation occurring at the instant of union of the reacting molecules, and thermal radiation from the products of combustion has become clearer.	Exact knowledge of the relative importance of the two effects is still missing.
The theoretical relations governing the position, in the spectrum, of the emission bands of gases radiating as a result of thermal excitation are known.	The theory is incomplete with respect to the calculation of the intensity of these emission bands for the purpose of predicting the effect of gases in radiant heat transmission.
	Little is known about effect of temperature gradient near surfaces on the interchange of heat by radiation between a gas and the surface, except that the effect is a source of serious error in calculations based on the assumption of uniform gas temperature.
	Difference between the absorptivity of surfaces for gas radiation and for black body radiation is not known.
Radiation from Luminous Flames	
General principles are known sufficiently well to permit interpretation of data on a luminous flame and application of the data to another similar flame.	No satisfactory method of predicting luminous flame radiation without experiments on similar flames.
Luminous flames are known to radiate more than non-luminous flames of same shape and temperature.	Knowledge inadequate to permit decision between relative merits of luminous and non-luminous flames in many heating problems.
Pulverized Coal Flames	
Emissivity of the flame is calculable in theory if one knows initial particle size distribution and the laws governing rate of combustion of the particles.	Particle size is not given by usual screen analysis. Laws of combustion of particles not known, consequently time-mean particle size not calculable.
General	
Good data on furnace performance are available for oil tube stills and steam boiler furnaces, and satisfactory correlation of data has been obtained.	No good data, complete with true temperature measurements and reliable heat flow quantities, are available for most furnaces in use in the chemical industry.
	Problems of unsteady-state heat flow in combination with radiant heat transmission through surfaces remain to be solved.
	Little is known about the effect of the diathermanous character of some liquids on the penetration of radiant heat into their interior.

[1]Total radiation measurements on carbon dioxide have just been completed, but are not yet published.

BOOKSHELF

The Imminence of a Petroleum Chemical Industry

THE CHEMISTRY OF PETROLEUM DERIVATIVES. By *Carleton Ellis.* Published by the Chemical Catalog Co., New York. 1,285 pages. Price, $18.
Reviewed by *S. D. Kirkpatrick*

THE PETROLEUM CHEMICAL INDUSTRY is only 15 years old, if by that we mean the direct production of chemicals *per se* from petroleum. Some work was done during the war pointing toward the manufacture of toluol from petroleum, but it is probably safe to say that the first commercial product was isopropyl alcohol made in 1919 by the Melco Chemical Co. and later by the Standard Oil Co. of N. J. from the propylene of cracking coil gases. The original process was that of Carleton Ellis, who since and even before that time has been intimately connected with the development of a petroleum chemical industry. He speaks, therefore, not only as a student of the literature but as one who has had a prominent part in its production.

That literature, incidentally, has mounted to enormous proportions during the past 15 years—so large in fact that it is difficult, if not impossible, for the individual worker to collect and collate the references for anything more than a small section of the field. This author and his staff began such a task for all petroleum derivatives over ten years ago and the time and labor were so great that it was decided to publish this material in book form so that it would be at the disposal of others interested in the development of this new field. The resulting volume of 1,285 closely packed pages, with more thousands of references than this reviewer wished to count, is indeed the most impressive contribution which has yet been made to the chemistry of petroleum derivatives. However, the intention of the author apparently was not merely to bring out another petroleum handbook. As the title indicates, the book is chemistry—organic chemistry exemplified by the reactions of petroleum and its derivatives. As such the interest associated with it would seem to be vastly broader than that of petroleum technology alone.

In a comprehensive work of this kind it has not been possible to give a detailed appraisal of the merits and demerits of the myriad of proposals. Nor will it be possible for this reviewer to do more than to hint at the content and philosophy underlying the 50 chapters of this book. In the main they begin with the chemical nature of petroleum and natural gas and then trace the production of their derivatives by processes such as thermal decomposition (pyrolysis, cracking), aluminum chloride, electrical transformation, hydrolysis, esterification, polymerization, halogenation, sulphonation, and — perhaps of most current interest and importance— the oxidation processes that are now giving us soap from petroleum, formaldehyde, acetic acid, etc. The chapter on the action of sulphonating agents on petroleum hydrocarbons, in which the manufacture of hard-water soaps is discussed, has over 300 footnotes, each with one or more literature references.

There are also comprehensive chapters on the carbon black industry, isopropyl alcohol from olefins, ethyl alcohol from ethylene, ketones, formaldehyde and other aldehydes, glycols, synthetic rubber, vinyl esters, synthetic fats and the naphthenic acids. In each of these fields there is a carefully organized, annoted, cross-reference survey of chemical developments in which the principal findings and conclusions of the various investigators are briefly stated in logical and chronological sequence. Nothing has been missed as far as this reviewer could learn from some five hours of more than casual examination. But the great value of the book, of course, lies in its usefulness as a reference library for the man who must quickly and accurately determine the status of development in any or all sections of this rapidly growing field.

Apart from commending the author for evident thoroughness and tremendous industry, this reviewer notes with considerable satisfaction that Carleton Ellis, despite some of the things we have been reading in the newspapers, is not one of those who hold that petroleum will ever replace coal tar as a source of all of our dyes and medicines. On the contrary, he sticks quite modestly to the view that progress in petroleum chemistry has been slow, but steady, with technology inclined to run somewhat ahead of the science. An extensive chemical industry founded on petroleum is gradually being built in this country and this book should do much to catalyze its progress.

WORLD RESOURCES AND INDUSTRIES. By *Erich W. Zimmermann.* Harper & Brothers, New York. 842 pages. Price, $5.

WITH TRADE BARRIERS and artificial restrictions obstructing the free flow of raw materials and manufactured goods between the various parts of the world a study of the world's economic resources is of great importance. The advantages and disadvantages of world interdependence and national self-sufficiency must be considered in all their complexity. The ultimate object of the present volume is to analyze agriculture, mining, and the manufacturing industries, and their relation to each other, to give the reader a broad view of the economic problems of our present civilization. A 20-page chapter on chemical industry is effectively presented from this viewpoint.

Russia's Industries

INDUSTRIALIZED RUSSIA. By *Alcan Hirsch.* The Chemical Catalog Co., New York. 309 pages. Price, $3.
Reviewed by *B. H. Strom*

AMONG the many books on Russia which have appeared during the last few years, this one should have a special appeal to engineers, particularly those of the chemical profession. The most important chapters of the book, as may be expected, deal with the development of the chemical industries, with which the author has been directly associated in the capacity of chief consulting engineer to the Soviet Chemical Industry. Although still in its infancy this industry is giving every evidence of a healthy growth, and the nation is rapidly taking its place among the world's leading producers of chemicals. Large plants for the production of basic materials such as acids, alkalis, potash, and phosphates are already in operation at strategic points throughout the country, and the more specialized products such as rayon, plastics, solvents, lacquers and paints, electrochemical specialties, and synthetic rubber are rapidly making their appearance.

The author proves a very sympathetic observer but apparently had no ax to grind. Whenever the opportunity presents itself he tries to give the reader a picture of the daily life of the people, and he discusses in an entertaining manner such subjects as art, amusements, religion, finance, and politics. He does not shut his eyes to failure and shortcomings when he encounters them. On the whole the reader feels that the author is in sympathy with the struggle of the people, that he believes in the justice of the cause and the motives of the leaders, and that he has faith in their ultimate success. He concludes the book with the following thought: "Our admiration should be not for the heights to which this interesting nation has reached at this stage in its development, but rather for the depths from which it has so painfully climbed."

X-rays in Industry

INDUSTRIAL RADIOGRAPHY. By *Ancel St. John* and *Herbert R. Isenburger*. John Wiley & Sons, Inc., New York. 232 pages. Price, $3.50.

Reviewed by *T. R. Olive*

IN THE PREPARATION of this volume the author's main objective has been to present the subject in a form which will be understood by students and engineers desirous of obtaining some useful knowledge of the fundamental theories involved. As no attempts have been made to produce a scientific treatise, the theoretical part has been discussed as briefly as possible without leaving out what may be essential for a comprehensive study and successful operation.

Industrial radiography applies radiant energy to non-destructive testing and is capable of assuring the designer that the objects examined are sound and satisfactory, or of supplying evidence and locations of any flaws and imperfections otherwise not visible. Its usefulness is steadily extending as more and more designers are awakened to its great possibilities. After treating the properties of x-rays and their production and recording the book takes up the industrial installations and applications. Several chapters are devoted to the testing of cast, forged, and welded equipment and structures.

Thermodynamics

AN INTRODUCTION TO THERMODYNAMICS FOR CHEMISTS. By *D. Johnston Martin*. Published by Longmans, Green & Co., New York. 343 pages. Price, $5.20.

Reviewed by *Frederick E. Schmitt, Jr.*

HERE IS an effort to induct the chemist into the field of thermodynamics, and to point out how its equations are applicable to problems of physical chemistry. Thermodynamics is an investigational tool of rank equal to the kinetic theory, and many of the more abstruse theories of physical chemistry may only be derived by its aid. The reader is conducted in more or less orthodox manner through the maze of classical derivations, and then the tabulated formulæ are applied to solutions of problems such as the theories of strong electrolytes, continuity of state, heterogeneous and ionic equilibria, and others. The author devotes a short section to the consideration of entropy from the point of view of the kinetic theory, through the concept of thermodynamic probability, which when taken together with his two-page conclusion makes for an unusual method of presentation. However, it should be noted that, for an introduction, too little effort is devoted to correlating relationships between the various phases of the science, leaving the usual network of symbol and formula through which the reader must make his own way.

THE THERMODYNAMICS OF ELECTRICAL PHENOMENA IN METALS. By *P. W. Bridgman*. The MacMillan Co., New York. 200 pages. Price, $3.75.

APPLICATION of the broad principles of thermodynamics is becoming a valuable aid in the study of the electrical properties of metals. The author has published a number of papers on this subject during the last ten years, the substance of which he is now presenting in book form, with the necessary extensions and modifications. A number of relations, not generally known, is revealed by thermodynamical arguments, and many interesting theoretical results have been presented.

Unit Chemical Processes

IN THE SYMPOSIUM on the "Unit Processes in Organic Synthesis," edited by P. H. Groggins and published in our May issue, pp. 265-74, the names and titles of the authors of the contributed sections were an follows: Merrell R. Fenske, assistant professor of chemical engineering, Pennsylvania State College; L. F. Marek, assistant professor of chemical engineering and director of Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology; H. P. Newton, associate chemist, Color and Farm Waste Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture; A. J. Norton, technical director, General Plastics, Inc., North Tonawanda, N. Y.; E. Emmet Reid, professor of organic chemistry, Johns Hopkins University; W. A. Simpson, chemical engineer, Charles Pfizer & Sons, Brooklyn, N. Y.; and A. J. Stirton, research chemist, Arlington Experimental Farm, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

This symposium on "Unit Processes in Organic Synthesis" was based in part on the manuscript of a forthcoming book of this title which is shortly to be published as one of the Chemical Engineering Series by the McGraw-Hill Book Co.

En Francais

PRINCIPES DE CHIMIE INDUSTRIELLE. By *W. H. Walker, W. K. Lewis*, and *W. H. McAdams*. Dunod, Paris. 762 pages. Price, 188 Fr. unbound, 199 Fr. bound.

A TRANSLATION into French of the second edition of Walker-Lewis-McAdams, with several additions to the text by the authors.

Metallurgical Texts

THE ALLOYS OF IRON AND TUNGSTEN. By *J. L. Gregg*. McGraw-Hill Publishing Co., Inc., New York. 511 pages. Price, $6.

THIS IS the third in the series of monographs issued by Alloys of Iron Research, the object of which is to present a concise, comprehensive and critical summary of research on ferrous alloys as reported in the world's technical literature. More than 1,800 such articles have been consulted in the preparation of the volume, of which about 1,300 have been extracted. Reference numbers have been used frequently in the text to permit ready access to the original sources of the published data and statements.

SAMPLING AND ANALYSIS OF PIG IRON AND CAST IRON. Third Edition. Published by Carnegie Steel Co., Pittsburgh. 200 pages. Price, $2.50.

THIS EDITION has been compiled through the cooperation of the chief chemists of all blast furnace plants of the subsidiary companies of the United States Steel Corp. Careful standardization of methods has been the chief objective, and the requirements of any method under consideration has been accuracy and general adaptability to routine analysis. The work has been carried through over a period of years, and the details of each method have been checked by many different analysts and in different laboratories.

THE CASTING OF BRASS INGOTS. By *R. Genders* and *G. L. Bailey*. Published by British Non-Ferrous Metals Research Association, London. 191 pages. Price, 15 s.

FOLLOWING an outline of the history of brass manufacture the principal part of this volume is a detailed analysis of the casting process and the extent to which the various factors affect the quality of the ingot. Among the factors considered are casting temperature, speed of pouring, feeding, dimensions of the ingots, mold coatings and the position of the molds during casting, and dissolved gases. Improvements in practice and modifications to better the quality of the ingots have been suggested.

METALLURGY OF IRON AND STEEL, IV Edition. By *Bradley Stoughton*. McGraw-Hill Book Co., Inc., New York. 559 pages. Price, $4.

SO MANY CHANGES have taken place during the ten years which have elapsed since the appearance of the previous edition of this book that a com-

plete revision and rearrangement of the subject matter has been found necessary. One of the objects of the rearrangement has also been to present the subject from an historical standpoint, a method of presentation which experience has shown to be the most interesting and instructive. A great deal more space has been devoted to the basic open-hearth process which now is so predominating from a tonnage standpoint, to the study of its physical equipment and the chemical progress so important to the quality. Space has also been given to the electrometallurgy of iron and steel and to the production of alloy steels.

From Over-Seas

ENERGETISCHE GRUNDLAGEN DER GASTECHNIK. By *J. Schuster.* Verlag von Wilhelm Knapp, Halle, Germany. 254 pages. Price, 17 Rm.

INCLUDED IN THE term, "Gastechnik," the author has grouped all branches of industry handling gases, whether physical or chemical reactions, or both, are involved. The subject has been classified in three main divisions, based on the three principal forms of energy—heat, electricity, and mechanical energy. Among the subjects dealt with in the various chapters may be mentioned gas reactions, heating and cooling of gases—with or without chemical reactions—evaporation and condensation, compression and expansion, gas reactions under pressure, purification of gases. A large number of tables giving the physical properties of the most important gases has been included.

BERL-LUNGE CHEMISCHE-TECHNISCHE UNTERSUCHUNGSMETHODEN. By *Ernst Berl.* Eighth Edition. Vol. V. Julius Springer, Berlin. 1,640 pages. Price, 136 Rm.

WITH THIS VOLUME the eighth edition of this outstanding handbook has been completed. The work is almost encyclopedic in its scope, and should be a valuable addition to any chemical library. Among the important subjects covered in this volume are sugar, wine, beer, and liquors, cellulose and paper, rayon, plastics, gelatine and glue, acetic acid, lacquers, textile chemicals, inorganic and organic dyes, leather and tanning materials.

ACHEMA JAHRBUCH, 1931-34. Published by Deutsche Gesellschaft für Chemisches Apparatewesen E.V., Seelze bei Hannover, Germany. 236 pages. Price, 10 Rm.

A REVIEW of the progress made in the construction of chemical apparatus since the time of the last Achema Exhibit, in 1930. Among important subjects discussed are standardization of laboratory equipment, welding of chemical apparatus, new materials of construction, description of new machinery, apparatus, and methods. A list of 2,000 types of apparatus and equipment displayed by 300 firms at the recent Achema Exhibit is also included.

LAQUE D'INDOCHINE. By *Georges Brooks.* 100 pages. Price, 18 Fr. LES PHÉNOMÈNES PÉRIODIQUES DE LA CHIMIE. By *Suzanne Veil.* 38 pages. Price, 15 Fr. L'INFLAMMATION ET LA COMBUSTION EXPLOSIVE EN MILIEU GAZEUX. *By M. Prettre,* 52 pages. Price, 15 Fr. EQUILIBRE DE MEMBRANE. By *N. Marinesco.* 68 pages. Price, 15 Fr. MECHANIQUE QUANTIQUE ET CHIMIE. By *G. Allard.* 31 pages. Price, 8 Fr. Published by Hermann & Cie, Paris, France.

A SERIES OF MONOGRAPHS on scientific and industrial problems in chemical and allied fields presented by French and Colonial authors.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Sugar. U. S. Tariff Commission Report No. 73, Second Series. Report to President on sugar, molasses, and sugar sirups, with statistical appendices, charts, and maps.

Quicksilver. U. S. Tariff Commission; mimeographed. Report to President on hearing and investigations under section 3(e) of National Recovery Act.

Laminated Products. U. S. Tariff Commission; mimeographed. Report to President on difference in costs of laminated products in U. S. and principal competing country.

Alcoholic Beverages. U. S. Tariff Commission, Miscellaneous Series; 15 cents. Information supplied by Tariff Commission at joint hearing before House Committee on Ways and Means and Senate Committee on Finance, December 12, 1933.

Liquor Laws, by Elmer A. Lewis. Document Room, House of Representatives. A compilation of all U. S. liquor laws from 1890 through June, 1933.

Importation of Alcoholic Beverages. Senate Document No. 117, 73rd Congress, 2nd Session. A report to the Senate by the Director of Federal Alcohol Control Administration.

American Branch Factories Abroad. Senate Document No. 120, 73rd Congress, 2nd Session. A report to the Senate by the Secretary of Commerce.

Experimental Studies of Natural Purification in Polluted Waters. VIII. Dissolved Oxygen in the Presence of Organic Matter, Hypochlorites, and Sulphite Wastes, by Emery J. Theriault and Paul D. McNamee. Public Health Service Reprint No. 1601; 5 cents.

Decisions of the National Labor Board, August, 1933-March, 1934. National Recovery Administration, unnumbered pamphlet; 10 cents.

The Microscopic Determination of the Nonopaque Minerals (Second Edition), by E. S. Larsen and Harry Berman. U. S. Geological Survey Bulletin 848; 20 cents.

Experimental Studies on Acute Mercurial Poisoning, by Sanford M. Rosenthal. Public Health Service Reprint 1605; 5 cents.

Increased Governmental Control in German Potash Industry, by Consul Sydney B. Redecker. Bureau of Foreign and Domestic Commerce, Chemical Division Special Circular No. 380; mimeographed.

Consolidation of German Nitrogen Cartel, by George R. Canty. Bureau of Foreign and Domestic Commerce, Chemical Division Special Circular No. 381; mimeographed.

Spanish Potash in 1933, by Claude I. Dawson. Bureau of Foreign and Domestic Commerce, Chemical Division Special Circular No. 382; mimeographed.

United States Imports and Duties, 1933. U. S. Tariff Commission Miscellaneous Series. Arranged according to schedules, paragraphs, and commodities under Tariff Act of 1930.

Gold-Recovery Studies, by E. S. Leaver and others. Bureau of Mines, Report of Investigations 3226; mimeographed. A progress report of the Metallurgical Division.

Silver Yield From Copper Ores and the Effects of 64.64-Cent Silver on the Value of Copper Ores Produced in the United States, by E. W. Pehrson. Bureau of Mines. Information Circular 6773; mimeographed.

Classification and Tabling of Alabama Red Iron Ores, by B. W. Gandrud and others. Bureau of Mines, Report of Investigations 3224; mimeographed.

Lead and Zinc Mining and Milling in the United States, Current Practices and Costs, by Chas. F. Jackson and others. Bureau of Mines Information Circular 6776; mimeographed. Abstract from an unpublished bulletin manuscript.

The Flotation of Alabama Graphite Ores, by B. W. Gandrud and others. Bureau of Mines, Report of Investigations 3225; mimeographed.

Mineral Production Statistics for 1933—preliminary mimeographed statements from Bureau of Mines on: Crushed and broken stone; molybdenum; magnesite; fuel briquets; asbestos; tungsten; rolled zinc; liquefied petroleum gases; fluorspar; potash; pyrites; cadmium; Indiana oolitic limestone.

Mineral Production Statistics for 1932—Separate pamphlets from Bureau of Mines giving detailed statistics to supplement chapters in Minerals Yearbook, 1932-33, on: Crude Petroleum and Petroleum Products, by G. R. Hopkins and A. B. Coons, 10 cents; Coke and Byproducts, by W. H. Young and others, 5 cents.

Federal Specifications. New or revised specifications of the Federal Specifications Board on: Wood-preservative, creosote (for) brush and spray treatment, TT-W-561a; wood-preservative, preservative-treatment, TT-W-571a; kerosene, VV-K-211; asphalt (for) built-up roofing, waterproofing, and damp-proofing, SS-A-666; copper-silicon-alloy, castings, QQ-C-593; zinc, plates, sheets, and strips, QQ-Z-301; rope, wire, RR-R-571. The above specifications are available from the Bureau of Supplies and Accounts, Navy Department.

Production Statistics From 1933 Census of Manufactures in preliminary mimeographed form for: Cardboard, not made in paper mills; matches; graphite, ground and refined; bluing; oilcloth.

List of Bulletins of the Agricultural Experiment Stations for the Calendar Years 1931 and 1932, by Catherine E. Pennington. Department of Agriculture, Miscellaneous Publication 181; 10 cents.

Diseases and Insects of Garden Vegetables, by W. W. Gilbert. Department of Agriculture Farmers' Bulletin 1371, Revised; 5 cents.

List of Technical Workers in the Department of Agriculture and Outline of Department Functions, 1933. Department of Agriculture Miscellaneous Publication No. 177; 10 cents.

OTHERS' VIEWS

The Purpose of the Union

To the Editor of Chem. & Met.

Sir—The Chemists' Section of the Federation of Architects, Engineers, Chemists and Technicians wishes to express its appreciation of your editorial in the April issue in which you point out the low salary scales for technical men. And this despite "the fact that important detailed work is in the hands of poorly paid chemists." With all his chemical education and experience the chemist is offered the handsome salary of $1,200 per year.

You justly point out that the chemist himself is largely responsible for this state of affairs. He has failed in the past to demand a salary commensurate with his training. Recent events have indeed shown the inability of the chemist's organizations to assume "human responsibilities." What's to be done about it? The Federation of Architects, Engineers, Chemists and Technicians is organized for this very purpose. It is an economic organization designed to protect the interests of technical men. In the recent general NRA hearing the Federation has filed through its representatives a detailed brief for a "blanket code" for technical employees in all industries, the chemical included. It is through such organized effort and with the cooperation of all technical men that the chemist and chemical engineer can really secure a decent livelihood and do away with "empty honors and emptier pocketbooks."

I. Ehrlich.
Secretary, N. Y. Chapter Federation of Architects, Engineers, Chemists and Technicians.

Editor's Note — We are pleased to print this communication although *Chem. & Met.* is yet to be convinced that the union offers the best approach to the problem of professional recognition. The program of the Engineers' Council for Professional Development outlined in our January issue appears to us at this time to be more logical and appropriate for the purposes stressed in our editorial.

Bouquets and Brickbats

Editor's Note: Not in several years have we received quite so many complimentary letters as those that have come to us as a result of the May issue of *Chem. & Met.* Forgetting our natural modesty this once, we would like to share a few of these comments with the readers of this column.

His Own Chemical Engineering File

To the Editor of Chem. & Met.:

Sir—Readers of your journal may be interested in this photograph of my

A Chemical Engineering File

chemical engineering file. The box represents an investment of 15 cents at the local Woolworth's. The alphabetical index and cards are the ordinary 3x5 library variety. I am sure the contents will be recognized as the flowsheets and new data on process raw materials published in the present volume of *Chem. & Met.*

I. M. Klipster
Chemical Engineer,
Aliquippa, Pa.

To the Editor of Chem. & Met.:

Sir—I want to compliment you for the splendid job you have done in getting out this valuable issue of *Chem. & Met.* There is a basis here for most valuable and lasting work, and I am sure will be very useful to and appreciated by those in chemical engineering work everywhere.

P. E. Landolt
Vice-president and Treasurer,
Allied Process Corp., New York.

To the Editor of Chem. & Met.:

Sir—I wish to congratulate you and the staff of your magazine on the particularly fine issue of May, 1934. Your exposition of the unit operations and unit processes of chemical engineering, the flowsheets of process industries and classification of chemical unit operations and equipment as outlined in the chart on page 230 are all worthy of the highest appreciation of the industry.

Wm. B. Baehr
Vice-President and Treasurer,
North Shore Coke & Chemical Co.,
Chicago, Ill.

To the Editor of Chem. & Met.:

Sir—I was glad indeed to get with my May copy of *Chem. & Met.*, the second of your series of data sheets of process industries. It seems to me that these will be of extremely great value to me in my teaching work. My purpose is to require the students to use them in connection with their study of chemical engineering.

H. L. Olin
Professor of Chemical Engineering,
State University of Iowa,
Iowa City, Ia.

To the Editor of Chem. & Met.:

Sir—The flowsheets of process industries which appeared in the last number of *Chem. & Met.* is a most masterly job. May I take this opportunity of congratulating you on such a highly informative piece of work relating to so many industries. It makes it more than worthwhile to be a member of the family of subscribers to this journal. A long life and continued high effort to you.

Gustav Egloff
Universal Oil Products Co.,
Chicago, Ill.

To the Editor of Chem. & Met.:

Sir—The May issue of *Chem. & Met.* was great. The flow diagrams in the supplement were fine and should be valuable in guiding individuals in the preparation of numerous designs covering all of their own and competitive processes. Incidentally, those flowsheets make up a dandy 3x5 file, as well as do the previous tables on commodities.

Arthur L. Davis
204 Ferris Hall,
University of Tennessee,
Knoxville, Tenn.

NEW EQUIPMENT

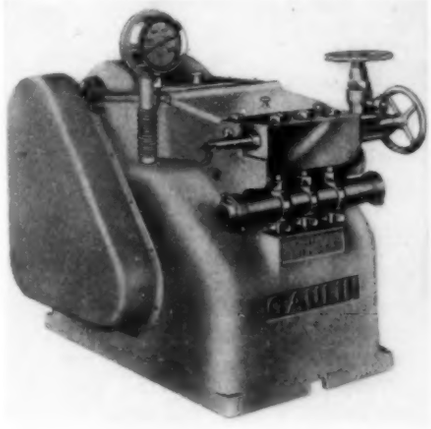
Improved Homogenizers

For the efficient production of emulsions and suspensions in the case of such products as pharmaceuticals, polishes and waxes, latex compounds, sizes, insecticides, cosmetics, tar emulsions and food products, the Manton-Gaulin Mfg. Co., St. Johnsbury, Vt., has introduced a complete new line of homogenizers known as Type CG. These are three-cylinder, two-stage machines, built in sizes ranging from 75 to 1,000 gal. Operating pressure, depending on size, ranges from 2,500 to 3,500 lb. pressure.

These machines are completely inclosed and readily accessible for repairs and cleaning. The motor is within the main casing where it cannot become wet or dusty. In the smaller sizes, drive is by means of a geared motor which operates the cam shaft through a chain. The largest size employs a V-belt drive and a herringbone gear reduction.

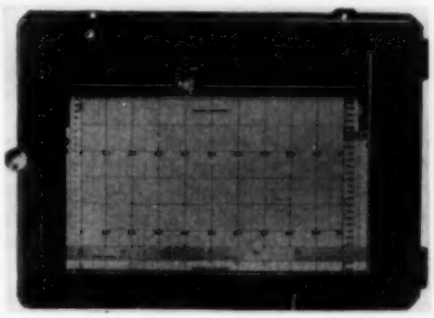
The pumping element consists of three plungers operated by heavy eccentrics. From the pump discharge manifold within the cylinder block, material passes through two separately adjustable homogenizing valves which are held by spring pressure at an opening of about 0.001 in. at 3,000 lb. After passing through each valve material impacts upon a ring, the design of which is said to be in considerable part responsible for the high efficiency claimed for this device. It is stated that the use of two homogenizing stages makes possible results unattainable by other means.

Two-stage homogenizer



Recording Potentiometer

Photoelectric balancing is employed in a new potentiometer recorder recently announced by the C. J. Tagliabue Manufacturing Co., Park and Nostrand Aves., Brooklyn, N. Y. Instead of the conventional galvanometer pointer, the new potentiometer uses a beam of light which is reflected by the galvanometer mirror through a system of shutters to the single photoelectric cell. These shutters, which operate on a 1½ sec. cycle, are so arranged that they present during their cycle five different areas through which the light beam may pass. When the beam passes through either of the two outer areas, the print carriage and potentiometer balancing mechanism moves continuously in one or the other direction, driven by a reversing synchronous motor. When the light beam is in the center area, the motor does not operate. When the beam is in either of the two areas bounding the center, an "inching" action of the balancing mechanism takes place in the proper direction.



Photoelectrically balanced potentiometer

The new potentiometer may be used to record from one to twelve temperatures in colors on a chart 10 in. wide. At intervals, the battery current is automatically recorded on the chart so that the condition of the battery at all times is apparent. Recording speed is such that a cycle of 12 temperatures is ordinarily completed in about five minutes, but for special purposes, with some limitations as to the spread of temperatures, this time can be reduced to two or three minutes.

Improved Valve

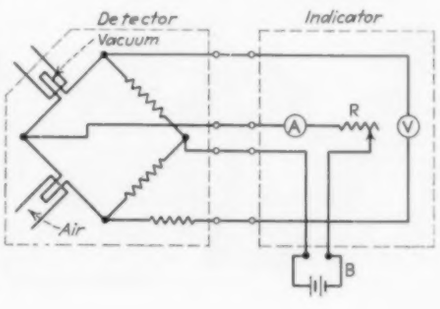
A full line of sizes between ¼ and 3 in. inclusive, for steam pressures to 150 lb., is available in the new Kennedy Fig. 89 globe valve and Fig. 90 angle valve made by the Kennedy Valve Mfg. Co., Elmira, N. Y. These new valves employ bronze bodies, stems and disk holders, with composition renewable disks and cadmium plated malleable iron packing nuts and bonnet rings. The use of malleable iron for these latter parts is said to be advantageous since the material better withstands rough usage from pipe wrenches than does bronze, while the cadmium plating is self lubricating. The packing nut is extra long; a ground joint is provided to make packing under pressure possible; and the design is such that ease of operation is said to be inherent.

High-Vacuum Gage

For the continuous and accurate measurement of vacuum, the Continental Electric Co., St. Charles, Ill., has developed a line of electric vacuum gages under the name of "Tru-Vac." The several gages of the line are adapted for various purposes, including the evacuation of high vacuum apparatus such as vacuum tubes and the filling of gas-filled tubes. One model is adapted to measuring the rougher vacuum required in process equipment.

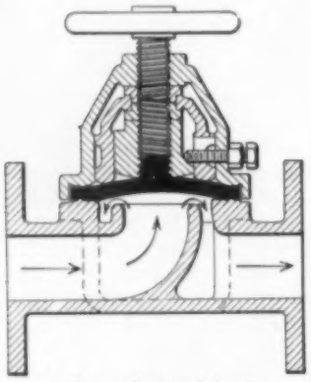
All models operate on the same circuit which is a modified thermal conductivity bridge. This circuit is shown in the accompanying illustration to consist of a wheatstone bridge, two of the resistances of which consist of filaments, one of which is maintained at atmospheric pressure and the other at the vacuum to be measured. A current

Circuit of "Tru-Vac" gage



impressed on the bridge, controlled by a rheostat and milliammeter, heats the two filaments. The rate of heat loss from the filament within the vacuum space (and its resistance) depends upon the quantity of air and of other gases and vapors present. The degree of unbalance of the bridge, shown by the millivoltmeter, therefore, depends on this rate of heat loss and consequently on the degree of vacuum.

As supplied, the gages are of the continuous indicating type. If desired, they may be provided with continuous recorders.



Corrosion-resistant diaphragm valve

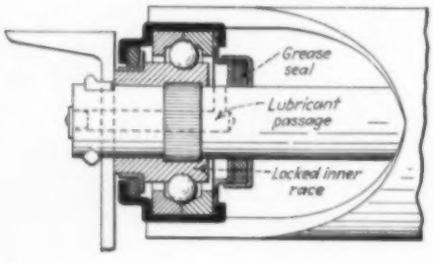
Diaphragm Valves

An adjoining illustration shows the principle of a new diaphragm valve recently announced by T. Shriver & Co., Harrison, N. J. The rubber diaphragm employed is mechanically supported in all positions and cannot become distorted, according to the manufacturer. All moving parts are completely separated from the liquids or slurries handled. Packing is eliminated and the valve is corrosion and abrasion resisting, non-clogging and easily disassembled for cleaning. The same principle is employed in a relief type of valve for use in lines between pumps and filter presses.

Conveyor Idler

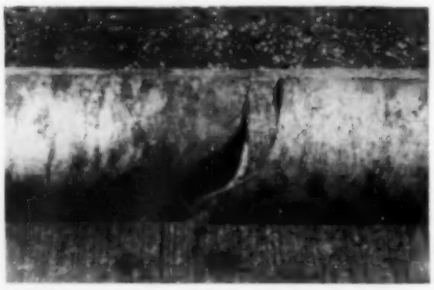
Mathews Conveyor Co., Ellwood City, Pa., has announced an improved conveyor roller in which the inner race of the heavy-duty ball bearing is locked to the axle by knurling. The axle, furthermore, is keyed to the conveyor frame rail and these two features assure a stationary axle and stationary inner race, preventing wear at these points and eliminating this cause of misalignment. The bearings are provided with ample grease seals and are lubricated through the axle by means of pressure fittings. The rollers are produced in various designs for loads from 2,000 to 8,000 lb. per roller.

"Gearlock" conveyor roller



Thermoelectric Pyrometer

Designed for use as standard equipment on heat-using machines, the new Hold-Heet pyrometer manufactured by the Russell Electric Co., 37 West Huron St., Chicago, Ill., is said to combine maximum accuracy with rugged construction and low cost. The pyrometer is of low resistance, thus giving high torque. It is of the direct-reading type and has manual cold-end correction adjustment. Instruments are made in two ranges, one from 60 deg. to 800 deg. F., and the other from 60 to 1,600 deg. F.

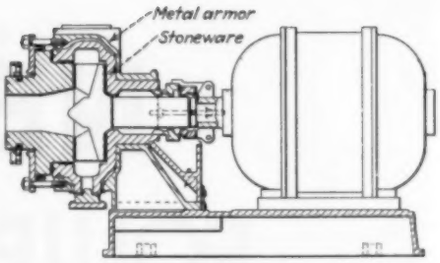


Correction — Through an inadvertence, an illustration purporting to be that of a broken section of United States Pipe & Foundry Co.'s new Super-De Lavaud pipe was published on p. 208 of our April, 1934, issue. The pipe shown was actually the company's older standard product. The illustration above shows the non-shattering characteristics of the new product.

Armored Stoneware Pumps

Compactness and high-speed operation are outstanding characteristics of the improved series of No. 520 pumps offered by the U. S. Stoneware Co., Akron, Ohio. The improved pumps use double packing glands with semi-automatic gland adjustment and temperature compensation to maintain constant gland pressure. The impeller clearances are adjustable and the impellers operate at 1,750 r.p.m. All stoneware parts are ground into the protecting armor, rather than being cemented in. Corrosion resisting alloys are used for all metal parts subject to possible corrosion damage.

These pumps are made in two styles,



Cross-section of No. 520-N chemical stoneware pump

the No. 520 type in which the impeller is carried on an outboard bearing, and the No. 520-N type in which the impeller is carried directly on the motor bearings.

Equipment Briefs

Rust-I-Cide is the name of a harmless, non-poisonous chemical rust remover introduced by the Rusticide Products Co., 1919 East 19th St., Cleveland, Ohio. The material is ready mixed and is said to do its work in ten minutes without heating or without the taking of special precautions on the part of the user.

For use both on new arc welding equipment and equipment now in use, the Lincoln Electric Co., Cleveland, Ohio, has developed the "Lincontrol," a device which permits the welder to control the welding voltage from a distance, simply by tapping the electrode on the work a larger or smaller number of times. The new device is said to improve quality and greatly to increase the output per welder.

Johns-Manville, 22 East 40th St., New York City, has announced a new Superex insulation block adapted to withstand temperatures up to 1,900 deg. F. The block is made of special calcined diatomaceous silica bonded with asbestos fiber. In addition to having higher temperature resistance, the new block is also said to have lower density and greater insulating value.

For use on refractories, The Relinus Co., Hempstead, N. Y., has developed a new heat resisting aluminum paint that is said to withstand temperatures over 1,500 deg. F., without fading. This company has also completed research work on a refractory paint for temperatures up to 3,000 deg. F. The latter is said to be a thin, super-refractory film, the reddish pigment of which turns to steel gray.

A new photoelectric relay for general industrial use, said to be much lower in price than former light-operated relays of comparable reliability, has been announced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The new "LE" relay interrupts 20 amp., 115 volt, a.c., non-inductive load or 3 amp., 115 volt,

d.c. It is stated that the design has eliminated the use of telephone relays.

For use in chemical plants, paper mills, gas works, oil refineries, sugar mills and other process plants, the Roots-Connersville Blower Corp., Connersville, Ind., is now supplying some of its blowers, vacuum pumps and gas pumps connected through a variable-speed drive to a constant-speed motor. The drive used is of the infinitely variable, side-contact belt and double-cone pulley type.

Commonwealth Electric & Manufacturing Co., 883 Boston St., Boston, Mass., manufacturer of miniature electric-heated steam boilers, has recently extended its line. Whereas its miniature boiler line previously covered current capacities from 2 to 5 kw., five new sizes, ranging from 7½ to 18 kw. have been added. The miniature line now covers steaming capacities to 54 lb. per hour and pressures of 100, 200 and 300 lb. gage.

For sealing gaskets and threads in oil, steam, water, air, and other pipe lines, the Ideal Commutator Dresser Co., Sycamore, Ill., has developed a compound called "Ideal Perfect Seal." The new material is said to be heat resisting to 400 deg. F., to seal tightly, and to permit quick and easy disassembly at any time.

Following the announcement in our issue of December, 1933, that the Cooley Electric Furnace Co., 433 North Capital Ave., Indianapolis, Ind., was prepared to supply electric furnaces containing the new Doreco heating element, it has now become known that this company is prepared to supply such heating elements as renewal units for all types of laboratory furnace equipment.

Brown Instrument Co., Philadelphia, Pa., has announced the development of a new meter body for electric flow meters. The new body is adapted to differential pressure ranges from 1.6 to 16 in. of mercury and is built of forged steel and heavy seamless steel tubing without welding. The operating pressure is 2,500 lb. per sq.in.

To permit economical replacement, the Merco-Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh, Pa., has developed a new line of lubricated plug valves with gate valve face-to-face dimensions. These valves are known as the Emco-Nordstrom type and are made in sizes ranging from 2 to 12 in. Both screw and flange types are available.

For the rapid and accurate determination of gasoline content of natural gas, both in the laboratory and in the field, the Podbielniak Laboratories, 222 East Superior St., Chicago, Ill., has developed what is known as the new Model K apparatus. The apparatus is said to be sufficiently portable for transportation from place to place in light trucks, and is enclosed in a special case designed for this purpose. No liquid air or accessories are required.

Sterling Electric Motors, Inc., Telegraph Road at Atlantic Blvd., Los Angeles, Calif., announces that the Vari-Speed motor described in our issue of April, 1933, is now being built also in an upright, enclosed design, in ratings to 15 hp.

MANUFACTURERS' LATEST PUBLICATIONS

Air Conditioning. Niagara Blower Co., 6 East 45th St., New York City—Bulletins 42-49, inclusive—Covering brine spray coolers, fan coolers, air conditioners, and cooling and heating equipment.

Air Conditioning. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Catalog AC-101—12 pages on the use of air conditioning in various industries.

Ceramics. American Lava Corp., Chattanooga, Tenn.—Bulletin 34—28 pages on electrical, mechanical and chemical uses of Alsimag and Lava ceramic parts.

Chemicals. R. & H. Chemicals Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.—8 pages on precious metal cyanides for metal plating.

Compressors. Carbondale Machine Co., Carbondale, Pa.—Bulletin 1233—12 pages on this company's vertical, duplex, ammonia compressors.

Couplings. Parker Appliance Co., 10320 Berea Road, Cleveland, Ohio—Bulletin 35—35 pages on this company's tube couplings and valves with information on materials and uses.

Dust Hazards. Northern Blower Co., West 65th St. & Barberton Ave., Cleveland, Ohio—Series of monthly folders on dust hazards, presenting information from unbiased sources.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1155—24 pages illustrating and describing motor generator sets; Leaflet 2173, 4 pages on squirrel-cage induction motors.

Electrical Equipment. Crouse-Hinds Co., Syracuse, N. Y.—Bulletin 2282—64 pages on explosion-proof condulets for hazardous locations, Class I, Groups A-D, and Class II, Groups E-G.

Equipment. Alphons Custodis Chimney Construction Co., 95 Nassau St., New York City—Leaflet describing this company's triple spiral packing rings for towers.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Bulletin GEA-1607A—4 pages on direct-current generators and exciters.

Electrical Equipment. Lincoln Electric Co., Cleveland, Ohio—4-page folder describing heat resisting properties and constructional features of this company's electric motors.

Electrical Equipment. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.—Bulletin 167, Part 8—4 pages on direct-current, compound-wound motors.

Equipment. John H. Barker, 154 Nassau St., New York City—Folder showing range of Chemical Equipment Co.'s equipment handled by this dealer.

Equipment. Robins Conveying Belt Co., 15 Park Row, New York City—Publications as follows: Bulletin 89, 8 pages on screen cloth for vibrating screens; Bulletin 90, 24 pages with data on this company's Gyrex vibrating screen; Bulletin 91, 8 pages on the Chance sand-flotation process for bituminous coal cleaning.

Equipment. Wallace & Tiernan Co., Newark, N. J.—Folder describing this company's MOF dry chemical feeder.

Filters. Goslin-Birmingham Mfg. Co., Birmingham, Ala.—8 pages on construction and operation of Vallez filters.

Furnaces. Cooley Electric Furnace Co., Indianapolis, Ind.—Catalog 34—6 pages on laboratory electric furnaces.

Heaters. Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet TB 30—6 pages on electric strip and immersion heating units.

Instruments. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio—Bulletin 44-A—32 pages on the savings effected by the use of this company's boiler meters.

Instruments. The Brown Instrument Co., Philadelphia, Pa.—Catalog 9001—32 pages on this company's resistance thermometers for indicating, recording and controlling.

Instruments. Esterline-Angus Co., Indianapolis, Ind. — "Solving Industrial Crimes, Case 2," booklet describing the use of recording instruments in lowering plant costs.

Instruments. The Foxboro Co., Foxboro, Mass.—4 pages on new non-indicating temperature and pressure controllers made by this company.

Instruments. H-B Instrument Co., 2518 North Broad St., Philadelphia, Pa.—"Blue Book, Part I," 48 pages on thermometers and psychrometers for industrial and scientific use.

Insulation. Johns-Manville, 22 East 40th St., New York City—30-page reprint of a lecture on high temperature insulation; 4-page folder on Sil-O-Cel C-22 insulating refractory brick for temperatures to 2,000 deg. F.

Linings. Patterson Foundry & Machine Co., East Liverpool, Ohio—Folder describing this company's Porox acid-resisting lining blocks and cement for the lining of acid-containing equipment.

Materials Handling. The C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland, Ohio—Bulletin 72—12 pages with illustrations and data on belt conveyor idlers.

Materials Handling. Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—This company's new general catalog, 1024 pages on mechanical-conveying, materials-preparation and power-transmission equipment.

Metals and Alloys. Chase Brass & Copper Co., Waterbury, Conn.—Form A-1008—31 pages on properties and uses of "Olympic Bronze."

Packing. Wm. B. Merrill & Co., 3368 Washington St., Boston, Mass.—12 pages on this company's "Tripplastic" packing, a packing containing metal, asbestos, graphite and lubricant.

Pipe. Johns-Manville, 22 East 40th St., New York City—18 pages with illustrations and data on Transite pressure pipe.

Power Transmission. Flexible Steel Lacing Co., 4607 Lexington St., Chicago, Ill.—72-page handbook for belt users, including information on this company's Alligator steel belt lacing.

Power Transmission. D. O. James Mfg. Co., 1114 West Monroe St., Chicago, Ill.—Folder describing this company's flexible couplings.

Power Transmission. Poole Foundry & Machine Co., Woodbury, Baltimore, Md.—4-page booklet describing recent improvements in this company's flexible couplings.

Power Transmission. Reeves Pulley Co., Columbus, Ind.—Form T-6700—15-page booklet describing construction of this company's variable speed transmissions.

Pulverizing. Foster Wheeler Corp., 165 Broadway, New York City—Bulletin P-34-2—24 pages on pulverized fuel equipment, thoroughly illustrated.

Pulverizing. Raymond Bros. Impact Pulverizer Co., 1302 North Branch St., Chicago, Ill.—8 pages on the use of this company's kiln mill in drying and grinding various products.

Pumps. The Deming Co., Salem, Ohio—Catalog 30—160 pages on this company's pumps, water systems and auxiliary parts and equipment.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: D-475-B9, 2 pages on internal-bearing, double-helical rotary pumps; W-311-B1, 4 pages on single-stage volute centrifugal pumps.

Pyrometers. Illinois Testing Laboratories, 141 West Austin Ave., Chicago, Ill.—Bulletins 1726 and 27—Respectively two and four pages on a surface temperature pyrometer for rolls; and a combination surface temperature pyrometer for various purposes.

Refractories. Quigley Co., 56 West 45th St., New York City—Bulletin 306—4 pages on "Q Chrome" neutral-base refractory cement for furnace construction and maintenance.

NEWS OF THE INDUSTRY

Manufacturing Chemists Association discusses labor and legislative problems at annual meeting. Tennessee Valley Authority works to interest chemical process industry groups to establish manufacturing enterprises in the Valley. Newspaper interests favor construction of newsprint mill in South. Tariff Commission schedules public hearing on camphor situation for June 21.

Record Attendance at A.I.Ch.E. New York Meeting

HISTORY was made in May, when 500 members of the American Institute of Chemical Engineers met in New York. This is the largest group of chemical engineers ever assembled in this country. Principles and practice of chemical engineering were discussed at the technical sessions.

Among the features of the social program arranged by the general committee, consisting of A. E. Marshall, president of the Institute, Percy Landolt, chairman of the local section, and S. D. Kirkpatrick, editor of *Chem. & Met.*, were the dinner at the Waldorf-Astoria, the dinner-dance at the Westchester Country Club and the boat trip to the Bayonne refinery of the Standard Oil Co. of N. J. On the last day of the convention activities were transferred to New Brunswick, N. J.

The student session was a very successful new feature. One hundred and thirty students, some from as far away as Illinois and North Carolina, attended. Robert V. Lukes from the University of Illinois won the Institute annual prize and honorarium for excellence in the solution of a chemical engineering problem. Scott Lyon, Ohio State University, and Waldeman A. Schmidt, Oregon State College, were given the 2nd and 3rd awards. Prizes given by the New York Section for the best original papers by students were as follows: First prize to Monroe Rapaport and Henry Ellner of the College of the City of New York; second prize to Donald Read and associates of Columbia University. Irvin Rimel of the University of Illinois received honorable mention.

Administration Members For Code Authorities

RECENT appointments of administration members on the code authorities of different industries include:

Carbon dioxide industry—Capt. Hubert B. Bramlet, New York City, commissioned officer of the Chemical Warfare Service, U. S. Army and a graduate of the Harvard Business School, Army Industrial College.

Agricultural insecticide and fungicide industry—George A. Prochazka, Jr., East Orange, N. J., a consulting chemical economist.

Printing ink manufacturing industry—August Rust-Oppenheim, New York City, president of Rust-Oppenheim, Waegen and Co., Inc., importers.

Hardwood Distillation industry—Capt. Harry R. Lebkicher, Chemical Warfare Service, U. S. Army.

NRA recognition also has been extended the personnel of the Emergency National Committee to administer the terms of the liquefied gas industry code. The members are: W. H. Anderson, United Motors Service Co., Detroit; J. J. Callahan, Hi-Heat Gas Co., New York; A. N. Kerr, Imperial Gas Co., Los Angeles; R. W. Thomas, Philgas Co., Detroit; Morse G. Dial, Carbide & Carbon Chemicals Co., New York; L. H. Spiner, Shell Petroleum Co., St. Louis; Mark Anton, Suburban Gas Co., Verona, N. J.; W. G. Oliver, Standard Oil Co. of Calif., San Francisco; W. F. Verkamp, Verkamp Corp., Cincinnati; Milburn Hobson, Skelgas Co., Kansas City; Dr. R. W. Miller, Hope Construction & Refining Co., Pittsburgh.

Fertilizer Men Appoint Zone Committees

CREATION of central and zone committees to handle trade complaints and labor complaints was one of the principal actions taken at the annual convention of the National Fertilizer Association June 12-13 at White Sulphur Springs, W. Va. Problems of code interpretation and compliance and open-price scheduling monopolized attention at the meeting which was keyed to the theme of self-regulation of industry by John Dickinson, Assistant Secretary of Commerce. Recent developments in technologic research were described by Dr. C. H. Kunsman, director of the fixed nitrogen laboratory of the Bureau of Chemistry & Soils and C. C. Concannon, chief of the Chemical Division of the Bureau of Foreign & Domestic Commerce, reported on foreign trade developments.

Tung Oil Investigated as Southern Cash Crop

TUNG oil is being given serious consideration as the cash crop for Southern subsistence homesteads. The division of subsistence homesteads of the Department of the Interior is looking into the situation and has asked for information from the Department of Agriculture and the chemical division of the Bureau of Foreign and Domestic Commerce.

Proponents of the idea enthusiastically proclaim that tung trees are ideally suited for this purpose as production of the oil will not compete with present crops. Private production of tung oil in the Southern Gulf States has been under way for sometime. About 44,000 acres are already devoted to tung nut culture. Probably one-third of this present acreage is sub-marginal, according to government officials. It is held that this country, which last year imported 118,000,000 pounds of tung oil, could consume oil from about 200,000 acres of trees in the South.

Manufacturing Chemists Meet at Skytop

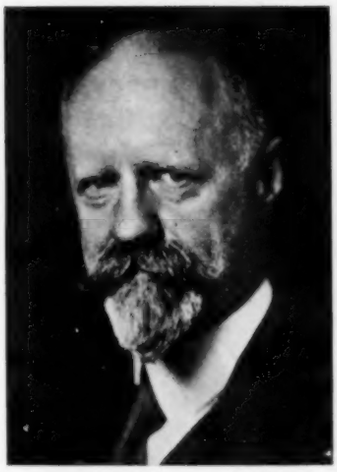
CHEMICAL executives gathered at Skytop Lodge in Eastern Pennsylvania for the sixty-second annual meeting of the Manufacturing Chemists Association on June 7-8, directed attention toward the wide range of new problems resulting from NRA and from recent legislation affecting industry. A prominent place on the program was given to Dean Clark, Director of the Chemical Code Authority whose paper "Labor Policies and the NRA" lead to an open forum discussion of difficulties arising from interpretation of Section 7A and from National Labor Board rulings. Strikes in all industries during the last six months of last year resulted in wage loss of forty-five million dollars, according to Mr. Clark, who added "the chemical industry is outstanding in its important relations to other industries. The very nature of its business requires exacting technical skill to insure quality and safety. Chemical plants and operations cannot be run from the outside."

Dean Clark cited the British Trade Disputes Act of 1927 as the most effective method yet developed for dealing with strikes. It makes illegal most sympathetic strikes as well as any other which extended beyond hours, wages, and employment conditions. In the discussion John C. Gall, associate counsel of the National Manufacturers Association, showed how very rapidly employee relationship is changing from a purely contractual to a legal basis.

The presidential address delivered by Wm. B. Bell, president of the American Cyanamid Co. was a stirring appeal for a prompt return to the principles of private enterprise as contrasted with the socialistic tendencies shown by public capitalism. He said "The time is coming when industry must throw aside its defensive attitude toward legislation and contribute constructively to a program of reform in corporate management."

Charles Belknap, chairman of the executive committee of M. C. A., presented the annual report, paying high tribute to the work of the technical committees, of Warren N. Watson, secretary, and of those responsible for the revival of the Chemical Alliance with subsequent formulation of its code. This, said Mr. Belknap, is "the best code in existence. It's main features are it's simplicity and it's limitations. It does not wander far afield and it has protective clauses which permit it's signers still to utilize discretion in the conduct of their businesses." Mr. Belknap also directed attention toward the work of the association in elimination of detrimental features in proposed legislation affecting the chemical industry.

George W. Merck presented the report of the nomination committee which



William Brown Bell

was followed by the re-election of existing officers and the addition to the board of Benjamin Meckling, representing the fungicide group.

At the joint banquet with the Synthetic Organic Chemical Manufacturers Association the principal speaker was Paul West Robey, financial editor and writer. The banquet was also the occasion for the presentation of the second award of the Chemical Industries Medal to William Brown Bell for his distinguished service to the chemical industry. Presentation was made by Horace Bowker, first president and founder of the Chemical Alliance.

New Process for Water Sterilization

INTERESTED bureaus in the government are investigating a patented process for sterilizing water by treatment with silver ions, recently introduced in this country by the representatives of a German firm.

The process, developed by Dr. G. A. Krause, Munich, Germany, is based on oligodynamy, the ability of a very small quantity of certain metals, particularly silver, to sterilize liquids, especially water.

Besides its use for sterilizing drinking, bathing and water for industrial uses, the process can be and is understood to now be used in Europe for sterilizing and esterifying fermented liquids. Use of the process for this purpose is said to prevent further fermentation and to aid in imparting a bouquet to the product.

Industrial interest in the process is quite apparent, according to reports from government bureaus. The most interest shown so far is said to have come from packing houses and swimming pools. The process is declared to have none of the obnoxious disadvantages of certain other filterants.

Chemical Equipment Makers Under Machinery Code

ON May 28, official notice was given that the definition of chemical equipment, as evolved by the Chemical Engineering Equipment Institute, had been approved and had become an amendment to the Basic Code of the Machinery and Allied Products Industry. The definition constitutes paragraph 40 of Article II of the basic code and reads as follows:

"Chemical Engineering Equipment Subdivision" means the manufacture, design, engineering, erection and/or licensing of chemical engineering equipment, together with its accessories and necessary housing, for sale, and/or the licensing of chemical engineering processes for use in connection with specified chemical engineering equipment, and shall be construed to include all persons engaged in such manufacture, design, engineering and/or erection for sale and/or such licensing; provided, however, that all specific equipment covered by other codes heretofore or hereafter approved under the Act is excluded to the extent of its coverage under such codes."

The significance of this amendment is that equipment manufacturers can now operate under the wage and hour provisions of the M.A.P.I. code and sign certificates of compliance in making bids where such certificates are required, as for instance, on government contracts.

In the meantime the chemical engineering equipment code which is supplemental to the basic code is in the hands of the code authorities for approval.

Committee Will Study Dye Industry of Italy

A NATIONAL dyestuffs committee has been formed in Italy for the purpose of studying the domestic dyestuffs industry and proposing measures for its protection and development. Details of the Committee's exact procedure are not yet available, but it is reported that a central sales bureau will be established to handle all transactions in dyes, both domestic and imported, and that licenses will be adopted for imports of dyestuffs.

Elizabeth Humes, trade commissioner at Rome, reports that Italy's domestic production of synthetic dyestuffs amounted to 6,200 metric tons in 1933 compared with 5,700 tons in 1932 and 7,500 tons in 1929, the peak year. Increased production in 1933 was accompanied by a 10 per cent rise in consumption. Imports were practically offset by exports and the volume of domestic production accounted for approximately 63 per cent of consumption.

NEWS FROM ABROAD

By Special Correspondents of Chem. & Met. at London and Berlin

London

THESE notes are written on the eve of your London Correspondent's departure for New York, and he is looking forward to renewing his personal acquaintance with friends and business connections. Having travelled very extensively in Europe during the last nine months it may be of advantage to "Chem. & Met.'s" readers to know that he will be pleased to deal, as far as time permits this month, with correspondence and inquiries addressed to him in care of the editor.

The combined effect of better domestic trade conditions and of a consistent import duties policy is reflected in the financial results and annual reports of British chemical concerns, among which Imperial Chemical Industries Ltd. deserve mention first. There is not only an increase of dividend to 7½ per cent but the annual report and the balance sheet disclose steady and satisfactory improvement and consolidation. The latter benefits incidentally from the new oil hydrogenation project which will take over about 10,000,000 dollars' worth of plant not now required for nitrogen fertilizer manufacture. In the former, reference is made both to steady home trade expansion and to the effect of Japanese competition; in particular trade in dyestuffs, dry ice, plastics, fertilizers and explosives have improved, and it is reported that the coal oil plant should be in operation by the end of the year. The undertaking of the Chemical and Metallurgical Corp. has been purchased and synthetic waxes and enamels further developed. The untimely death of Sir Max Muspratt severs one more link in the alkali chain—a charming personality, of high ability and character, who will be sadly missed.

The exodus from Germany is both inconvenient and of value to science and industry. In many cases German and other technologists have been instrumental in starting new factories and industries and there has been much public and private hospitality and help to ensure that valuable brains are not wasted provided the personal side is reasonably acceptable.

A large party from England visited the chemical plant exposition (Achema) at Cologne under the auspices of the Association of British Chemical Plant Manufacturers. The exposition was on lines similar to those of previous years, and its continual growth was mainly due to the untiring work of Dr. Max Buchner, who died suddenly a month ago. Some of his interesting processes and inventions still remain to be developed but the exploitation of German inventions and the export of German goods is becoming increasingly difficult and prices below cost have to be accepted if only to secure foreign exchange for the importation of vital raw materials; this again invites further tariff measures and the outlook seems obscure.

Two interesting portable plating apparatus are now on the market. The idea is some years old, but now for the first time it would seem that really satisfactory deposits not only of nickel but also of chromium are obtained. These methods are of course only applicable to garage, domestic, and other casual application and will not compete with the output of established plants. Of these the new large Metalion Factory, previously referred to in these notes, will shortly be in operation, and there a new thick chrome deposit direct on steel is also being commercially developed.

The future of the rayon industry remains obscure, but the general outlook is hopeful, except for the smaller Viscose producers. For plants similar to these the installation of small soda and caustic soda plants has been mooted, and there are now two processes available in Germany and Belgium respectively which will enable substantial savings to be made on present contract prices.

The new president of the Society of Chemical Industry is Edwin Thompson, the former Lord Mayor of Liverpool, whose official visit in that capacity to New York will be remembered.

Berlin

THE PROGRESS made lately in German oil production was reflected in the lectures and reports presented at the German Society for Petroleum Research. Prof. Ubbelohde, the chairman, was able to state that in an emergency the German liquid fuel and lubricant requirements may be supplied from domestic production, even if the expected doubling of the demand, due to increased consumption in transportation, should be realized during the next 4-5 years. In this connection an annual production of about 400,000 tons of crude is assumed, and great expectations are also held to the direct high-pressure coal hydrogenation as well as to the synthesis from carbon monoxide and the coal and lignite distillation. No increase took place in the consumption of motor fuel during last year, in spite of the greater number of motor vehicles in use; one reason for this was that many vehicles were replaced with new ones using less gasoline, another that the cost of motor fuel is still too high. The high price of gasoline has also caused a shift to the diesel engine which now has almost completely conquered the field of freight hauling. An effort is made in Germany to maintain the advantage over other countries gained in this field, and in the future to supply as much as possible of the diesel fuel from domestic production.

A general effort is made to produce mineral oils from German raw materials. For this all lignite distillation plants should first be put into full operation. But still greater quantities of mineral oils would be obtained if all of the present lignite production suitable for distillation, that is, with a bitumen above 6.5 per cent, were to be distilled. To do this it would be necessary not to burn the lignite itself, but to work it for mineral oil and then use coke instead of lignite for firing. This seems possible because by briquetting the lignite prior to distillation a solid lump coke may be obtained instead of the powdered semi-coked material formerly produced, a coke which would be well suited for domestic fuel.

The pitch and also the fuel oil obtained in the treatment of the distillation tar could be utilized in the hydrogenation. Although today only lignite with above 6.5 per cent bitumen is considered suitable for distillation, the possibility exists that future improvements in distillation and in coal washing may lower this limit, to for instance 5.3 per cent.

Some other papers of technical importance must be mentioned. Decomposition and hydrogenation of cresols at reduced pressures were investigated by Obenaus. At 900 deg. C. mainly a condensation of two cresol molecules with only a partial splitting off of the oxygen occurred; above 1,050 deg. C. the oxygen was removed almost completely in the form of carbon monoxide by splitting the hexagonal bond. At temperatures up to about 1,000 deg. C. the hydrogen added has hardly any action on the cresol itself, but only on the products of decomposition. Fundamentally light hydrocarbons may therefore be obtained from pure cresol at high temperatures; the behavior of the technical

products must, however, still be ascertained.

Orlovius found that in thermal decomposition of cracking gases from the Dubb plant in Misburg, Hannover, the individual saturated hydrocarbons possess different tendencies to decomposition. Only a mean optimum yield may thus be obtained when the total gas mixture is treated. The quantity of unsaturated hydrocarbons in the gas could be raised from 7.5 to 25.4 per cent by thermal decomposition. Ethylene and acetylene are mainly involved.

Dr. Pott pointed out that in England only 400,000 tons of coal are distilled annually, in spite of great efforts and expense to increase this figure. This is also possible only because the coke produced may be used as smokeless fuel in the English fireplaces, that is, not as a competitor with coal. In Germany, however, the distillation was given up in 1929 because no good use could be found for the tar. Coal distillation, according to Dr. Pott, will only be possible in Germany, when a coke of excellent qualities is obtained, which will take care of the expense of the entire process.

The difficulties in disposing of coke, according to Dr. Weitenhiller, caused many plants to use the coke ovens as distillation ovens to obtain a light-burning coke. These experiments did not meet with success until the coal was mixed with pre-oxidized coal, as a coke resembling distillation coke was first obtained. But the cost of this process is so high that it can only be operated economically in exceptional cases.

Puening uses iron heating surfaces in the so-called BT distillation process, in order to work with the lowest possible temperatures (not above 600 deg. C.); he also uses narrow retorts to permit the charge to pass through quickly. The retorts have movable walls to permit easy discharge and the coal is packed into the retorts. Even heating is attained by rotating the retorts, and changing the direction of rotation. Figures presented made it appear that the price difference between the distillation products and the coal is about twice the interest and amortization charges.

Soltkahn called attention to the fact that the annual volatilization losses of gasoline in the tanks commonly used in Germany amounted to about 3.8 per cent, but could be reduced by 80 per cent to about 0.7 per cent, by using so-called "floating covers."

Dr. Weller Bochum reported on his experiences with separation of resin from light motor fuel. Addition of alcohol reduces the capacity of motor fuel to keep in storage; copper salts and soaps have the same effect. While copper increases the resinification, iron—galvanized and tinned—has no harmful effect.

Code Authority Group Named For Equipment Trade

ANNOUNCEMENT of the basic code authority group elected to conduct the code operations of the country's leading machinery builders has been made by John W. O'Leary, president of the Machinery and Allied Products Institute.

In addition to Mr. O'Leary, who will act as chairman, the code authority group will include the following: P. C. Brooks, executive vice-president, Fairbanks, Morse & Co., Chicago; Paul C. DeWolf, vice-president, Brown & Sharpe Mfg. Co., Providence; W. C. Dickerman, president, American Locomotive Co., New York; Robert E. Friend, president, Nordberg Mfg. Co., Milwaukee; Leo W. Grothaus, Allis-Chalmers Mfg. Co., Milwaukee; George H. Houston, president, Baldwin Locomotive Works, Philadelphia; A. M. Mattison, president, Mattison Machine Works, Rockford, Ill.; Denis F. O'Brien, president, The A. P. Smith Mfg. Co., East Orange, N. J.; N. W. Pickering, president, Farrel-Birmingham Co., Ansonia, Conn.; W. S. Shipley, president, York Ice Machinery Corp., York, Pa.; George P. Torrence, president, Link-Belt Co., Chicago; Guy A. Wainwright, president, Diamond Chain & Mfg. Co., Indianapolis.

Officers Nominated For A.S.T.M.

ON Monday, June 25, the thirty-seventh annual meeting of the American Society for Testing Materials will open with committee meetings at Chalfonte-Haddon Hall, Atlantic City. The first general session will be held on the following day and the meeting will continue through June 29. Officers nominated for the ensuing year are: W. H. Bassett, The American Brass Co., president; H. S. Vassar, Public Service Electric and Gas Co., Irvington, N. J., vice-president; H. A. Anderson, Western Electric Co., H. J. Ball, Lowell Textile Institute, W. M. Barr, Union Pacific Railroad Co., L. S. Marsh, Inland Steel Co., and J. B. Rather, Socony-Vacuum Corp., members of the executive committee.

At the meeting the ninth Edgar Marburg Lecture will be delivered by Dr. Sheppard T. Powell of Baltimore whose subject will be "Water as an Engineering and Industrial Material."

The Charles B. Dudley Medal awarded annually by the society will be received by R. L. Templin, chief engineer of tests, Aluminum Co. of America.

Solvay Process to Build at Baton Rouge

AS THIS issue goes to press we learn from reliable sources that the Solvay Process Co. will build a completely integrated alkali plant on river front property at Baton Rouge, La. Thus is put at end the uncertainty regarding the location of this plant as first reported in the January, 1934, *Chem. & Met.*, page 38. As pointed out at that time the choice was between the Baton Rouge and Houston areas although it is understood that exhaustive studies of many other sites have been made by the company during the past 5 years.

The Baton Rouge property will permit direct shipment by ocean vessels as well as by rail. Part of the plant's output will probably move by water to Hopewell, Va., to supply the requirements of Solvay's associate, the Atmospheric Nitrogen Corp. The Solvay Process Co. is the largest producer of alkalis in the world. It was the first to produce soda ash in the United States, its Syracuse plant having started production as early as 1882.

Record Carbon Black Sales Last Year

PRODUCTION of carbon black in 1933 amounted to 269,325,000 lb. This was 26,625,000 lb., or 11 per cent, over the 1932 figure. Total sales, amounting to 374,644,000 lb. in 1933, were far in excess of the previous high record established in 1929 and were 43 per cent over the 1932 figures. Of the total sales, 222,358,000 lb. (59 per cent) represented domestic deliveries and 152,286,000 lb. (41 per cent) represented exports. Domestic sales were 38 per cent above those in 1932, while exports were 52 per cent higher than in 1932.

Of the total domestic deliveries 191,358,000 lb., or 89 per cent, was consigned to rubber companies. This compares with 81 per cent in 1932, showing that the rubber industry is more than maintaining its place as a consumer of carbon black. Sales to ink companies showed a slight increase in quantity, but amounted to only 8 per cent of the total domestic sales, compared with 11 per cent in 1932. Sales to paint companies decreased slightly but sales for miscellaneous purposes increased 21 per cent.

In general, all foreign customers increased their purchases in 1933, in some cases the gains amounting to more than 100 per cent. The United Kingdom, France and Germany, in the order named, continued to be the chief customers. December was easily the leading month for exports as the foreign buyers anticipated the higher prices which became effective early in 1934.

NEWS FROM WASHINGTON

By PAUL WOOTON

Washington Correspondent of Chem. & Met.

THE reciprocity bill, passed virtually unchanged and now in effect, gives broad bargaining powers to the administration, and can be used not merely to get lowered tariffs for American goods entering foreign countries, but also to obtain changes in their import quotas for American goods, reductions in excise taxes which affect American goods (just as the coconut excise tax affects Philippine oil even though it comes in free) and exchange allocations abroad. In return for these favors to American exports, the President is now authorized to reduce existing duties by 50 per cent (or to raise them for fighting purposes) for a period of 3 years from the date of the agreement. Notice must be given the affected industries in this country, that is, those which compete with the imported goods receiving the benefit of lowered duties. The reductions apply to all imports of the article in question from any country, but by picking items of outstanding interest to a certain country (e.g., flaxseed, which comes overwhelmingly from Argentina) appreciated favors can be given to interested countries.

Some 25 countries have talked more or less real business with the State Department since the reciprocity plan began to look feasible, and negotiations with half a dozen countries are now under way. The list includes: Sweden, Colombia, Argentina, Brazil, and Portugal.

There is considerable evidence for the belief that the Latin American countries are going to be especially favored in the negotiations, even if the whole plan was not originally conceived for the actual purpose of building up a close and intimate American (in the sense of the whole Western hemisphere) trade area. There is reason to believe, for instance, that in the negotiations a way may be found to get Brazil to pay for its imports (chiefly flour and wheat) from Argentina with New York coffee bills, which will thus create dollar exchange in Buenos Aires for the purchase of American automobiles, chemicals, etc. And of course a greater allocation of the foreign exchange created in Brazil itself by our coffee purchases to pay for Brazilian imports from this country.

The negotiations of the reciprocity agreements will be handled, of course, by the Department of State as the agency having to do with foreign affairs of every sort. Much of the actual work will be done however by the interdepartmental committee on foreign trade, created some months ago under the chairmanship of Assistant Secretary of State Francis B. Sayre and embracing representatives from State, Commerce, Treasury, agriculture and independent commissions and bureaus like RFC, the Export-Import Bank and George N. Peek, special adviser to the President on foreign trade. Mr. Peek is sure to wield great influence in the negotiations, and may indeed become titular head of some sort of loosely organized inter-department bureau under the reciprocity act.

Power and Aluminum

To encourage industrial power utilization, Tennessee Valley Authority has been negotiating with a number of chemical process industry groups with whom it was hoped to establish contracts contemplating purchase of power and building of manufacturing enterprises in the Valley. Thus far no such contracts have been entered but a few negotiations continue on rather a promising basis. Most prominent in the group have been those contemplating manufacture of electrochemical or electro-metallurgical products. T.V.A. itself has thus far embarked on industrial matters of chemical character only in the field of fertilizer. Its cement plans have not yet matured, at least for announcement.

Most talked of in Washington has been the proposal of Standard Aluminum and Alloy Co. That enterprise was formerly expected to be a major customer of the private hydro-electric development at Aurora which was held up because T.V.A. asked the Federal Power Commission to decline to give any authority for power development on the Tennessee River, except under T.V.A. control. This aluminum enterprise remained, therefore, without power affiliation and has been presented separately. If developed, it would use a new process for aluminum manufacture developed by Gaudy Engineering Service of Chicago, of which R. J. Gaudy is chief. Bauxite would come from Arkansas deposits controlled by an affiliated group which certain New York promoting interests control.

Application was made to P.W.A. for a loan of twenty million dollars which, it was proposed, would be used for the building of the new plant which would then take power from T.V.A. Secretary Ickes frankly repudiates any intention to grant such loan. He says that the government would go into this kind of enterprise only if it acquired the bauxite deposits and went into the business directly. Much as the government would like to see a competitor for Aluminum Company of America, there is no evidence yet that they are willing to take this drastic step of being the competitor.

Paper in the South

Advocates of a new Southern paper and pulp industry have not only stirred up critics in the present industry but also run afoul of official criticism in the Department of Agriculture. A lively controversy, not at all calmed by the editorial policy of certain Washington Hearst newspapers, has, therefore, been going between Senators and Congressmen from the South and some of the newcomers in Secretary Wallace's organization.

Washington expects definite attempts at commercialization of the ideas of Charles H. Herty, developed to quasi-commercial scale at Savannah, either through the T.V.A. or through some commercial group in the South. One of the most encouraging non-government moves has been the appointment of a special committee to study the project of newsprint from Southern paper industries, as named by the president of Southern Newspaper Publishers Association late in May. At their meeting at Asheville, this group decided that they should back a project to bring about the construction and operation of a newsprint mill. J. G. Stahlman of the Nashville Banner is chairman. Other prominent committee members are from the Atlanta Constitution, Beaumont Enterprise, Charlotte Observer, Roanoke Times, Birmingham News, Knoxville News-Sentinel, and Louisville Courier-Journal.

Accelerated Leather Test

Quick determination of the aging characteristics of leather may be possible under recommendations by R. W. Frey and C. W. Beebe of the Bureau of Chemistry and Soils, of high-temperature artificial atmosphere exposure. In a report on this to American Leather Chemists Association recently it was concluded that such a test would permit determination in 3 to 6 months as to the resistance of leather to atmospheres containing the characteristic content of those sulphur compounds that are now believed to be the principal cause of deterioration, reddening, and breakdown of leather in bindings, upholstery, and other household and industrial products. These tests have shown that certain types of leather, well known to be more resistant in these respects, can be identified in a relatively short period.

Trends in Domestic Production Of Acetic Acid

ACETIC ACID is steadily becoming an important industrial chemical, both as the acid and in its derivatives, the anhydride and the various esters. Production of these compounds must be considered as a group because of the economic, as well as technologic, interdependence.

Hitherto no really significant data have been available because studies have not distinguished accurately between primary and secondary or recycled recovery of the acid or its compounds. The latest Tariff Commission inquiry from which data have just been issued does, however, make a clear distinction and for the first time gives a reliable indication of trends. This shows the not unexpected variation in consumption reaching a peak in 1929 of 155 million lb. of glacial acetic acid equivalent, dropping off during the three subsequent years to a low in 1932 of 86 million lb., but again rising last year to approximately 138 million lb.

In the immediate post-war years substantially all acetic production in the United States was from wood distillation and the product reached the primary market as calcium acetate. Even as late as 1927 approximately 85 per cent of the United States manufacture was in this form from this source.

About 1927 three significant competitive methods of production became of sufficient magnitude to deserve consideration. These were direct recovery of acetic acid at wood distillation plants; production of acid by fermentation processes; and direct synthetic manufacture in the United States. Tariff Commission census returns necessarily group together these three methods of manufacture in order to avoid revealing operations of single companies to their trade competitors. It is known, however, that through 1932 calcium acetate continued as first in rank as a producer. But in 1933 for the first time synthetic processes are estimated to have equalled, or possibly exceeded, calcium acetate manufacture.

During the 7-year period in question, fermentation acid, which at the start was second in importance, has not grown as rapidly as either direct recovery at wood distillation plants or synthetic manufacture. For the next few years it is expected, therefore, that production will be, in order of importance, from synthetic plants, direct recovery and calcium acetate at wood distillation plants, and lastly fermentation.

The confusion in earlier statistics, above referred to, has usually resulted from the fact that no account has been taken of the technical interlocking of the several stages of the acetic acid and acetate business. One example of this will suffice to show the complexity and the difficulty of statistical analysis.

One of the hardwood distillers is an affiliate of an important chemical-engineering enterprise. This wood distillation plant makes as an intermediate sodium acetate and from this, not acetic acid, but rather acetic anhydride. This chemical is transferred to an affiliated works making rayon. In that works some of the anhydride stays permanently in cellulose acetate. Some of it is recovered as very weak acetic acid. The weak acid is in turn concentrated to glacial grade and shipped to still another works of the same parent company. There it is formed into various esters and enters into miscellaneous chemical manufacture. If one reported the production at each stage, he might have a single quantity of acetic acid radical appearing as many as five times in the production of this one company. Such duplication, of course, would be utterly misleading, but unfortunately has prevailed often in the past. There are few cases quite as complicated as this, but more than enough to have confused investigators in the past.

Another consideration that has not always been adequately taken into account is the fact that several of the hardwood distillation plants do not make either calcium acetate or direct recovery acetic acid. The one above cited makes acetic anhydride. One of the important works in Michigan makes only ethyl acetate. Another makes acetate first but markets only acetic acid produced by a sulphuric-acid conversion process. Still another in New York occasionally makes methyl acetate. Until the present figures from the Tariff Commission were at hand no complete quantitative separation, all calculated on a common basis, could be obtained. The present data summarized in the accompanying table have eliminated such duplications and give, calculated on a common basis of 100 per cent glacial acetic acid, all of the primary production, regardless of the form in which the material reaches its primary market or passes into consumption in intra-plant use.

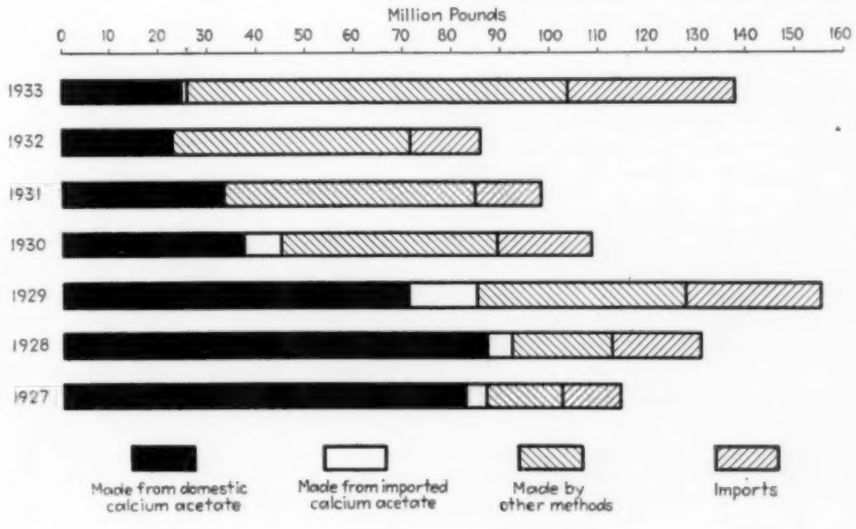
Domestic Production of Acetic Acid

(Thousands of Pounds)

Year	Primary Production — From Calcium Acetate[1] — Dom. Cal. Acetate[2]	Imp. Cal. Acetate[2]	Total	By Other Methods[4]	Total[4]	Percentage of Total Represented by Calcium Acetate	Other[4]
1927	82,966	3,939	86,905	15,488	102,393	84.9	15.1
1928	87,217	5,146	92,363	20,146	112,509	82.1	17.9
1929	71,273	14,048	85,321	42,443	127,764	66.8	33.2
1930	37,292	7,920	45,212	44,404	89,616	50.5	49.5
1931	33,482	0	33,482	51,703	85,185	39.3	60.7
1932	22,940	0	22,940	48,516	71,456	32.1	67.9
1933	25,294	150	25,444	78,519	103,963	24.5	75.5

[1]Converted on the basis of one pound of 100 per cent acetic acid to 1.75 pounds of 80 per cent calcium acetate.
[2]Based on monthly reports of the Bureau of the Census and adjusted for stocks on hand at beginning and end of year.
[3]Assuming conversion to acid during year of importation.
[4]Including acetic acid equivalent of derivatives.

Process Trends in Acetic Acid Manufacture



NAMES IN THE NEWS

V. A. COSLER has joined E. I. duPont de Nemours & Co., Wilmington, Del. He will be employed in the rubber chemical division.

LAWRENCE M. DEBING, a research engineer with Bakelite Corp. and later the holder of that company's fellowship at Columbia, is with Resinox Corp.

PERCY A. LASALLE, who resigned from the Bell Telephone Laboratories a few years ago to complete his studies leading to a Ph.D. degree at Penn. State, has joined Thomas & Hochwalt, Dayton.

THOMAS S. TAYLOR, for many years with Bakelite and more recently with Boston Blacking & Chemical Co., has resigned to accept a professorship in physics.

WM. R. HUEY, an expert on materials of construction for the duPont company, has become associated with Continental-Diamond Fibre Co. in the capacity of technical sales engineer.

WILLIAM SEAMAN, formerly with the International Paper Co., is now with the Calco Chemical Co., Bound Brook, N. J.

WARREN A. QUADENFIELD, who was in the materials division of the general engineering department of the Standard Oil Co. of N. J., is now with Foster Wheeler Corp.

C. F. LANDSHEFT, a former sales engineer with General Plastics, is now with the Boonton Molding Co., Boonton, N. J.

B. J. CROSS, who for ten years prior to 1931 was associated with the engineering activities of Combustion Engineering Corp., rejoined the company on May 1.

C. C. STEWARD has resigned his position as refinery engineer with the Consolidated Steel Corp. of Los Angeles and has accepted a similar position with Foster Wheeler Corp., New York.

HOMER EATON has become associated with the Pulp and Paper Laboratory of the Industrial Committee of Savannah as assistant chemist. Dr. Charles H. Hertz is director of the laboratory.

Hiram S. Lukens

HIRAM S. LUKENS, head of the department of chemistry and chemical engineering at the University of Pennsylvania, has been elected president of the Electrochemical Society. Dr. Lukens succeeds Dr. John Johnston.

ORLANDO F. WEBBER, while retaining the chairmanship of the board of directors of Allied Chemical & Dye Corp. has retired from the presidency. H. F. Atherton has been appointed president.

THOMAS J. LACKNER has resigned his position as research chemist at the Bell Telephone Laboratories to become associated with the Accurate Manufacturing Co., Garfield, N. J.

ELBERT C. LATHROP, formerly director of research and development of the Celetex Co., and consulting chemical engineer, Chicago, has become associated as technical director with the Crown Williamette Paper Co., Camas, Wash.

JAMES L. DOWNS, former research chemist for the Roessler & Hasslacher Chemical Co. at Niagara Falls, recently received the Jacob Schoellkopf medal awarded by the Western New York Section of the American Chemical Society.

BRUCE L. BAILEY of the Norton Co., Chippawa, Ontario, was awarded the prize to young authors at the Asheville meeting of the A.E.S. His paper was on the subject of hardness values for electrochemical products.

CLYDE E. WILLIAMS has been appointed director of the Battelle Memorial Institute by the Trustees of the Institute. He succeeds Dr. H. W. Gillett, who will be chief technical advisor.

A. C. RICHARDSON, CHESTER R. AUSTIN, and BRUCE W. GONSER have been appointed to the staff of the Battelle institute.

FRANK H. DRIGGS, who has been in the research laboratory of the Westinghouse Lamp Co. at Bloomfield, N. J., for several years, has joined the Fansteel Products Co. at North Chicago, Ill.

WITHROW MORSE, who was formerly connected with Jefferson Medical College as professor of chemistry and toxicology, and later with Rohm & Haas, is now with the Lederle Laboratories.

EDMUND BILLINGS has been elected vice-president of Godfrey L. Cabot, Inc. For the past ten years he has been sales manager of the Cabot organization.

EDWARD HERING has become acting chief engineer of the United States Pipe & Foundry Co., Burlington, N. J. He succeeds T. P. Anthony.

CHARLES L. WAGNER, formerly in charge of sales and development for J. O. Ross Engineering Corp., has formed the firm of consultants, Charles L. Wagner and Associates, New York City.

D. R. WIGGAM has been appointed assistant director of the Hercules Experimental Station, Wilmington, Del.

PRESTON LUNSFORD, for a number of years assistant to the president of Tennessee Products Corp., has recently been named general manager of Hardwood Charcoal Co.

CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 25-29.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, fall meeting, Portland, Ore., Sept. 10-13.

AMERICAN CHEMICAL SOCIETY, fall meeting, Cleveland, Sept. 10-14.

ELECTROCHEMICAL SOCIETY, fall meeting, New York, Sept. 27-29.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, fall meeting, Pittsburgh, November, 1934.

OBITUARY

WILLIAM HOSKINS, dean of Chicago chemical engineers, died May 18 at his home in La Grange, Ill., following a year's illness. He was 72 years of age.

DR. HOSKINS was born in Covington, Ky., in July, 1862. He became assistant to G. A. Mariner, consulting chemical engineer in 1880. During the War he served on the Naval Consulting Board as an expert on chemical warfare and was adviser to the Bureau of Mines when the bureau had charge of chemical warfare. He was president of the Hoskins Process Development Co. and since 1890 head of the firm of Mariner & Hoskins, consulting chemical engineers. Dr. Hoskins was chairman of the Chicago section of the American Chemical Society and was the first president of the Chicago Chemists Club.

ALFRED J. JUPP, a vice-president of the Lunkenheimer Co., Cincinnati, died suddenly in New York, April 10, while on a business trip.

DAVID E. REID, head of the industrial chemical laboratory of the Kodak Park Works of Eastman Kodak Co., died April 16 at his home in Rochester, N. Y. Dr. Reid had been with the Eastman organization since 1904. His advancement was rapid. Among his accomplishments was the development of a number of patents for the betterment of the company's products.

WILLIAM H. SCHEEL, head of the New York firm carrying his name, which he founded in 1889 to deal in chemicals, colors, varnish and other gums, died March 14. He was 85 years old.

HERMAN A. METZ, a director and vice-president of American I. G. Chemical Corp., died May 17 in the New Rochelle Hospital of a stomach ailment. He had been taken to the hospital a few days before when he suddenly became ill at his summer home on Orienta Point, Mamaroneck, N. Y.

After a long career in the chemical and dye business, he became active in the formation in 1926 of the General Dyestuff Corp., of which he became president. A strong advocate of friendly relations between the United States and Germany, Mr. Metz served from 1924 until his death as president of the Board of Trade for German-American Commerce.

JESSE BRIGGS CHURCHILL, consulting chemist for the city of New York, died at his summer home at Plymton, Mass., May 21 at the age of 59. He had been in ill health for four months. During the War Mr. Churchill was engaged in special work at the Pittsburgh and Washington stations of the U. S. Bureau of Standards. His interests at that time were mostly concerned with development of war gases.

FOREST SHATTUCK, who retired from the Solvay company in 1919, died April 11 at Beverly Hills, Calif.

H. E. HORTON, chief chemist of American Maize-Products Co., Roby, Ind., died suddenly after a short illness at his home in Whiting, June 6. He had been, for the past 35 years, closely associated with the chemical development of the wet processing corn industry, being one of the earliest chemical workers in the field.

David Wesson

DAVID WESSON, a pioneer in the development of cottonseed oil products, died May 22 of a heart malady at his home in Montclair, N. J., after being ill for three weeks. He was 73 years old.

In the field of chemical engineering he is internationally known for his work on cottonseed as a raw material of chemical manufacture. In 1902, while he was at Savannah, in charge of operations of the refineries of the Southern Cotton Oil Co., he commenced the development of the distillation of fatty acids from cottonseed soap stocks. Six years later he designed and put in operation the Bayonne plant of the company. Later his research work resulted in developing among other things the process of hydrogenation used by his company for hardening oils.

MR. WESSON graduated from M.I.T. in 1883, and was assistant to Professor Nichols the next year. He was the chemist for N. K. Fairbanks Co., chemist for American Cotton Oil Co., president of Wesson Manufacturing Co., general manager of Wesson Process Co., and manager of the technical department of the Southern Cotton Oil Co. The American Institute of Chemical Engineers honored him with the presidency in 1920 and 1921.

ARTHUR HOUGH died March 10 in his 65th year, while visiting in St. Petersburg, Fla. He had not been in good health for several months and died of a cerebral hemorrhage.

MR. HOUGH was born in England in 1869 and came to America in 1893. During the War he constructed the T.N.T. and gun cotton plants in Canada for Curtis & Harvey, Ltd., of England. The T.N.T. plant was the first to turn out the refined product on this continent. Perhaps he is best known for his work on the production of nitric acid with which his name will long remain associated.

E. V. BENJAMIN, president of the Bay Chemical Co. and of the Myles Salt Co., Week's Island, La., died recently. Mr. Benjamin was born in Cincinnati in 1868 and went to New Orleans at the age of 20 years and soon afterwards with E. W. Mente founded the paper company of E. W. Mente & Co. In 1919 he retired from the paper firm and bought the salt company.

ELMER E. MAINS, chemist and metallurgist for the Detroit Steel Coating Co., died April 30 after a four months' illness. He was 66 years old. Mr. Mains had been with the company for 44 years.

WILLIAM COOPER PROCTER, chairman of the board of Procter & Gamble Co., died May 2. He was 71 years old. Colonel Procter had been ill only a few days when he died in Holmes Hospital in Cincinnati.

E. WILLIAM BAXTER BADER was killed June 9 when the plane in which he was a passenger crashed into the side of a mountain in the Western Catskills. He was 31 years old. After graduating from Massachusetts Institute of Technology he became associated with the Semet Solvay Co., Buffalo, N. Y.

HENRY T. KOENIG, who gained an international reputation for his work on the recovery of radium from the ore, died in Denver on May 20 at the age of 42 years. Mr. Koenig had been in a sanitarium for several months suffering from cancer which had been indirectly caused by his work on radium. After graduating from the University of Pittsburgh and Princeton he joined the Radium Corp. of Colorado and was sent to Olen, Belgium, where he worked with Mme. Curie.

CHEMICAL ECONOMICS

Manufacturing operations in the chemical industry were speeded up during April and May with reports of a slowing up in the present month. Production of basic chemicals does not appear to have been materially changed in the last few months with stabilized outputs apparently having been planned. Current production influenced by slower consuming demand.

ON A comparison of consumption of electrical power, there was a substantial increase in the index for all industry production in April. Production of chemicals in that month increased over that reported for the preceding month but not to the same extent as the rise in all industry. The index number for chemical production in April was 132.8 as compared with 132.3 for March, while the all industry index was 111.3 for April and 104 for March.

Manufacturers of chemicals report a mixed trend for operations in May, with seasonal influences responsible for curtailment of some lines and for increases in others. The composite picture, however, shows that the rate of production was again upward and the index number for the month was 134.7. Labor troubles became a factor of some importance, causing a let-down in some plants where labor difficulties actually were experienced and inducing increased activities in other plants where such troubles were merely prospective.

Since the turn of the month trade reports have been heard to the effect that some of the important consuming trades were less active and that diminished call for raw materials was reflected in the output of chemicals with the belief that production would be modified throughout the hot weather period, which would be in marked contrast to the conditions which prevailed through the summer of 1933.

Sales of paint, varnish, and lacquer products in April were valued at $27,768,932 compared with $19,043,787 for April, 1933. For the first four months of this year, sales reached a valuation of $89,321,434 while the total for the like period of 1933 was $55,563,485 or a gain of more than 60 per cent for the present year. The total for April exceeded that for any month of 1932 and that for every month of 1933 except June.

Production of boxboard for the first four months of this year was reported at 952,830 tons as against 872,578 tons for the first four months of last year or an increase of a little more than 9 per cent for this year.

For the first five months of 1934 the sales of fertilizer tags in the 12 southern states were 16 per cent larger than they were for the same months of 1933, and were about 37 per cent larger than the sales for the first five months of 1932. With the exception of North Carolina, which showed a decrease of three per cent, each of the southern states had larger sales than for the first five months of 1933. For the first five months sales in the five midwestern states were 45 per cent larger than the sales for the first five months of 1933, and 25 per cent larger than the sales for the first five months of 1932.

Consumption of crude rubber by manufacturers in the United States for the month of April amounted to 44,947 long tons, which compares with 47,097 (revised) long tons for March. April consumption shows a decrease of 4.6 per cent under March, but was 73.4 per cent above April a year ago, according to statistics released by the Rubber Manufacturers Association. Consumption for April was reported to be 25,928 long tons, a revision of the total previously reported.

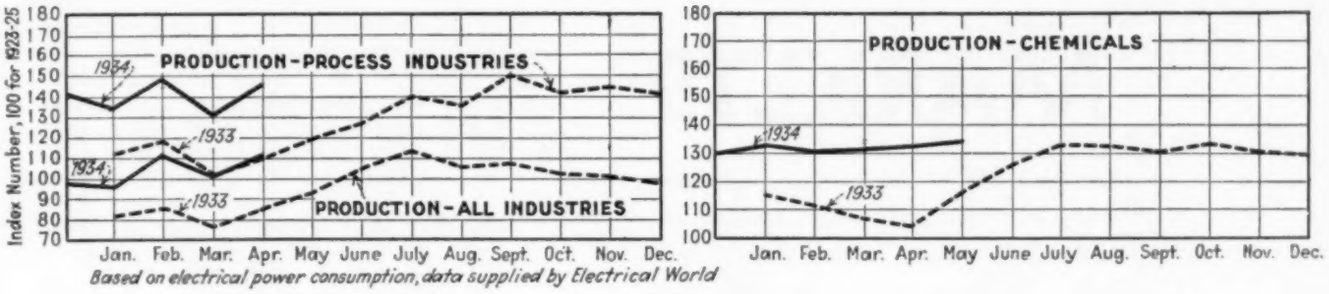
According to *Textile Organon* the May index for rayon production was 273 as compared with 289 for the preceding month. Corrected for seasonal variations, however, the index showed a slight gain for May. The publication cites two reasons for the slower deliveries in May. First was the uncertainty caused by price declines which tended to restrict buying and second was the fact that stocks in consumers' hands had been built up by heavy buying in past months in anticipation of higher prices. The latter condition appears to hold good for the textile trade generally and manufacturing operations for the next month or more are expected to reflect this condition.

While varying reports are heard regarding the automotive industry, it can be stated that a high rate of output was maintained in the first half of the current month and the total for the month may exceed that for June last year, which was the peak of 1933. This year's output already exceeds that of 1933.

Production and Consumption Data for Chemical-Consuming Industries

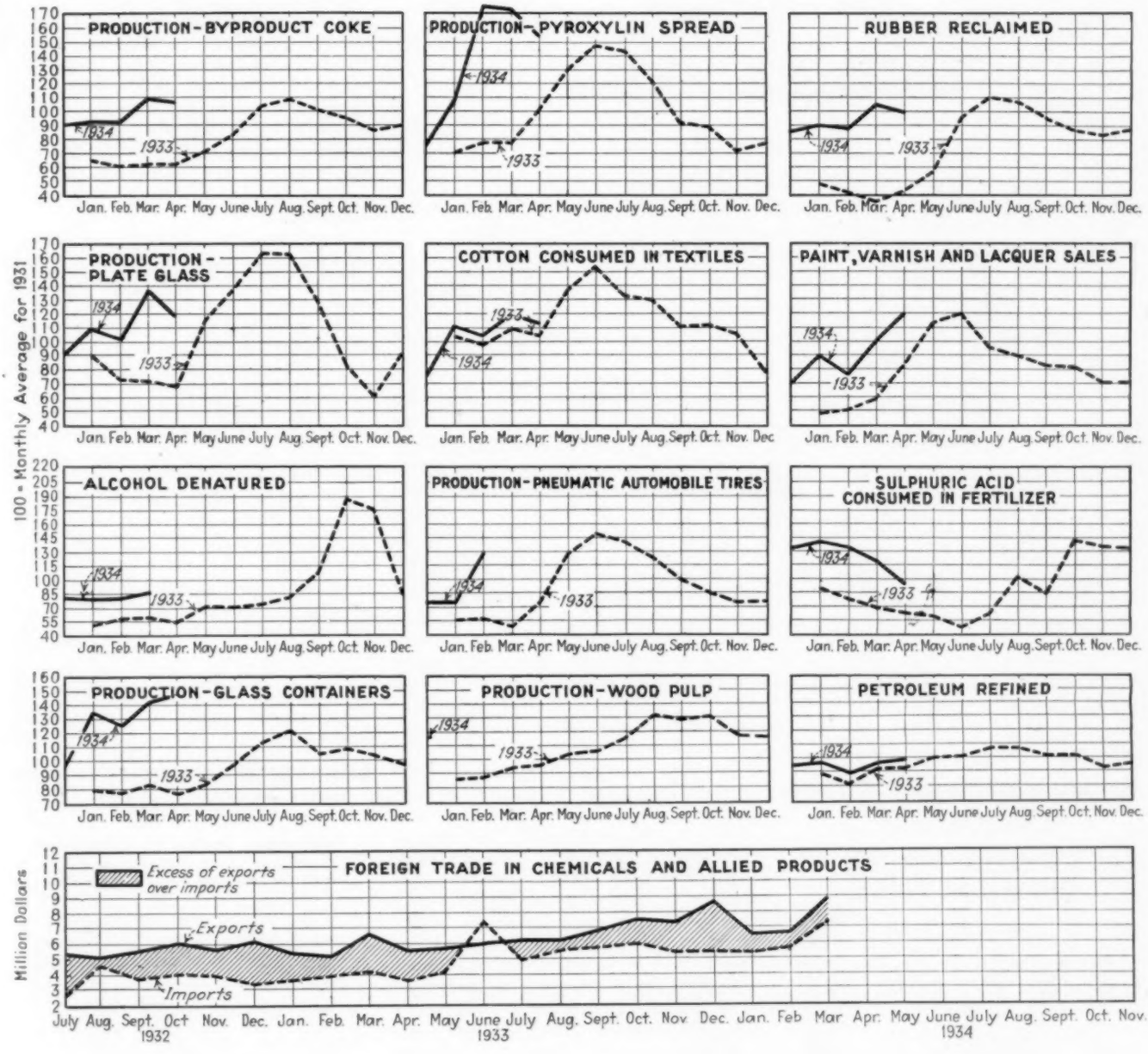
	April 1934	April 1933	Jan.-April 1934	Jan.-April 1933	Per Cent of Gain, Jan.-April 1934
Production					
Automobiles, no.	360,620	180,713	1,093,103	535,690	104.1
Byproduct coke, 1000 tons	2,875	1,656	10,813	6,746	60.3
Cellulose-acetate plastics, sheets, rods, tubes, 1000 lb.	510	149	1,709	578	195.7
Nitro-cellulose plastics, sheets, rods, tubes, 1000 lb.	1,384	604	4,918	2,317	112.3
Glass containers, 1000 gr.	3,032	1,568	11,322	6,493	74.4
Plate glass, 1000 sq.ft.	8,629	4,680	33,604	20,704	62.3
Cottonseed oil, crude, 1000 lb.	58,201	81,531	452,899	470,108	3.1*
Cottonseed oil, refined, 1000 lb.	95,850	98,252	456,569	432,168	5.6
Petroleum refined, 1000 bbl.	73,563	68,822	283,352	263,941	7.2
Pyroxylin spread, 1000 lb.	4,681	2,894	18,441	9,722	89.7
Steel barrels, no.	657,185	452,086	2,634,421	1,532,141	72.6
Sulphuric acid produced in fertilizer trade, tons	119,619	73,900	535,594	367,671	45.7
Rosin, wood, bbl.	45,454	24,926	185,170	108,294	71.0
Turpentine, wood, bbl.	7,729	3,831	30,870	17,236	79.0
Rubber reclaimed, tons	10,185	4,340	39,147	17,243	127.1
Consumption					
Cotton, 1000 bales	513	470	2,043	1,876	8.9
Wool, 1000 lb.	29,889	28,701	136,324	122,432	11.3
Explosives, sales, 1000 lb.	26,958	16,197	108,771	66,857	62.7
Sulphuric acid in fertilizer trade, tons	107,842	71,649	552,561	337,738	63.6

*Per cent of decline.



Based on electrical power consumption, data supplied by Electrical World

TRENDS OF PRODUCTION AND CONSUMPTION


PRODUCTION - BYPRODUCT COKE
PRODUCTION - PYROXYLIN SPREAD
RUBBER RECLAIMED
PRODUCTION - PLATE GLASS
COTTON CONSUMED IN TEXTILES
PAINT, VARNISH AND LACQUER SALES
100 - Monthly Average for 1931
ALCOHOL DENATURED
PRODUCTION - PNEUMATIC AUTOMOBILE TIRES
SULPHURIC ACID CONSUMED IN FERTILIZER
PRODUCTION - GLASS CONTAINERS
PRODUCTION - WOOD PULP
PETROLEUM REFINED
Million Dollars
Excess of exports over imports
Exports
Imports
FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS
July Aug. Sept. Oct Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov Dec. Jan. Feb Mar Apr. May June July Aug. Sept. Oct. Nov.
1932
1933
1934

MARKETS

Tapering off of manufacturing operations in important industries has resulted in reduced deliveries of chemicals. The price tone is less firm than in the preceding month although the more important selections maintain a steady price level. Public hearing will be held to determine whether synthetic camphor is important enough to warrant tariff protection.

SEASONAL slowing up has been reported in different consuming industries in the last few weeks. This has been reflected in demand for chemicals and other raw materials. All branches of the textile industry have cut down on buying orders and slower conditions have prevailed in the glass, fertilizer, and soap trades. Not only has this affected the spot market but, in some cases, it has extended to a slowing up in the movement against existing contracts.

The relatively quiet position of the market has developed an easier price tone for some selections. On the other hand, practically all of the basic chemicals have held an unchanged position and there has been no definite downward price trend.

Public hearings will be held June 21 by the U. S. Tariff Commission to determine whether the ratio of domestic production of synthetic camphor to domestic consumption of all camphor is sufficient to continue the 5-cent import duty on the synthetic product. Under the Tariff Act of 1930 this duty is continued for another year only if it be demonstrable that 30 per cent of domestic consumption of camphor is from domestic synthetic sources. Those acquainted with the trade are thoroughly convinced that this demonstration will be easily made with a generous margin to spare. A year hence the domestic industry will be expected to demonstrate a 50 per cent share in consumption. If that demonstration is made next year, then the 5-cent tariff continues indefinitely instead of reverting to the one-cent per pound level which applies now to crude natural camphor only.

Those interested in the naval stores industry hope that in connection with the encouragement of synthetic camphor some offset can be arranged for the materially increased cost due to NRA wages affecting turpentine. They point out that the resulting increase in turpentine price adds to the difficulty of profitable manufacture of camphor synthetically. There has been no formal application made for hearing on this subject thus far. Action by the Tariff Commission will, therefore, not begin until some unit in the industry makes such formal request.

A report from Washington states that the Peruvian Ministry of Public Works is investigating the possibilities of exploiting the sodium nitrate deposits found in the pampas of the Sihues region in the Department of Arequipa. It is expected that when the engineer's report is available the State will issue the necessary legislation to encourage and protect the establishment of this industry in the country.

The improvement in demand for Chilean nitrate of soda is indicated by another report which places exports from Chile during the week ended May 12, 1934, totaling 8,898 metric tons, as compared with 10,772 tons in the previous week and 24,058 tons in the week ended April 28. The cumulative total from July 1, 1933, to May 5, 1934, reached 1,064,170 tons as compared with 165,874 tons in the corresponding period of 1932-33.

The license for the wood naval stores industry establishes a system of marketing quotas, which, during the period from April 2, 1934, to Dec. 31, 1934, shall not exceed 71,000 bbl. of wood turpentine and 399,000 bbl. of wood rosin. This quota is apportioned among the various branches of the processors as follows: 57,000 bbl. of wood turpentine and 399,000 bbl. of wood rosin to the processors of steam distilled wood turpentine and wood rosin; 9,000 bbl. of wood turpentine to the processors of this product by the sulphate method, in which it is a byproduct to the manufacture of paper, and 5,000 bbl. of wood turpentine to the processors of this product by the method of destructive distillation.

Using past data for the industry as a basis, a control committee will determine the apportionment of the quotas among the individual processors.

On October 1 of each year, the control committee will estimate the quantity of wood turpentine and wood rosin which will be available on January 1 of the ensuing year and on the basis of this estimate and market surveys will determine the marketing quotas of the ensuing calendar year.

Further reductions in price schedules for potash salts direct attention to the competitive conditions which prevail in that market. A picture of dark prospects for domestic producers is being painted by foreign trade observers on the basis of recent shipments of the chemical from Soviet Russia. These observers hold that the Soviet is selling potash in the United States for political capital instead of profit, hoping thereby to build up credit possibilities.

CHEM. & MET.
Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	**88.35**
Last month	88.46
June, 1933	85.37
June, 1932	85.27

Potash, naval stores, tin and lead salts were offered at lower levels with a steady tone holding for the majority of the chemical list. The weighted index dropped slightly.

CHEM. & MET.
Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	**57.48**
Last month	56.94
June, 1933	55.73
June, 1932	38.30

The price movement was mixed with linseed and China wood oils higher and palm, coconut, and corn oil showing an easier tendency. Animal fats, which are expected to advance, were lowered in price but glycerine advanced.

CURRENT PRICES

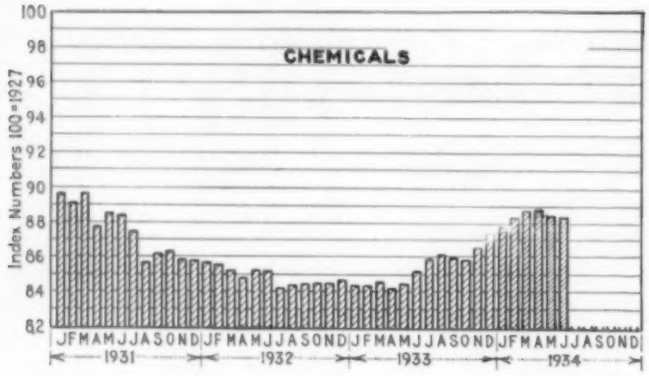
The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to June 13.

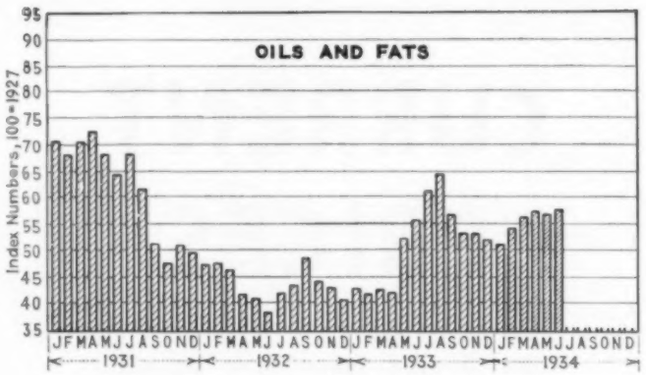
Industrial Chemicals

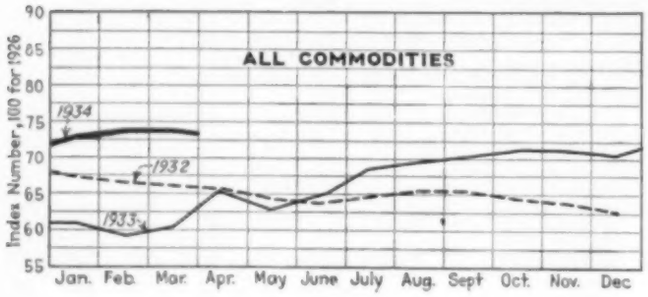
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.11 -$0.11½	$0.11 -$0.11½	$ .08½-$0.09
Acid, acetic, 28%, bbl., cwt.	2.90 - 3.15	2.90 - 3.15	2.78 - 3.03
Glacial 99%, drums	10.02 -10.27	10.02 -10.27	9.33 -
U. S. P. reagent, c'bys.	10.52 -10.77	10.52 -10.77	9.64 - 9.89
Boric, bbl., lb.	.04½- .05	.04½- .05	.04½- .05
Citric, kegs, lb.	.28 - .31	.28 - .31	.29 - .31
Formic, bbl., lb.	.11 - .11½	.11 - .11½	.10 - .11
Gallic, tech., bbl., lb.	.60 - .65	.60 - .65	.55 - .60
Hydrofluoric 30% carb., lb.	.07 - .07½	.07 - .07½	.06 - .07
Lactic, 44%, tech., light, bbl., lb.	.11½- .12	.11½- .12	.11½- .12
22%, tech., light, bbl., lb.	.06 - .06½	.05½- .06	.05½- .06
Muriatic, 18° tanks, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton.	18.50 -20.00	18.50 -	18.50 -20.00
Oxalic, crystals, bbl., lb.	.11½- .12½	.11½- .12½	.11 - .12
Phosphoric, tech., c'bys., lb.	.09 - .10	.09 - .10	.08½- .09
Sulphuric, 60°, tanks, ton.	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton.	15.50 -	15.50 -	15.50 -
Tannic, tech., bbl., lb.	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb.	.26 - .26½	.26 - .26½	.20 - .21
Tungstic, bbl., lb.	1.40 - 1.50	1.40 - 1.50	1.40 - 1.50
Alcohol, Amyl			
From Pentane, tanks, lb.	.143	.143	.143
Alcohol, Butyl, tanks, lb.	.095	.095	.095
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.15½-	4.15½-	2.53½-
Denatured, 190 proof			
No. 1 special, dr., gal.	.346-	.34-	.34½-
No. 5, 188 proof, dr., gal.	.34 -	.34 -	.38½-
Alum, ammonia, lump, bbl., lb.	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb.	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb.	.03 - .04	.03 - .04	.03 - .04
Aluminum sulphate, com., bags, cwt.	1.35 - 1.50	1.35 - 1.50	1.25 - 1.40
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb.	.02½- .03	.02½- .03	.02½- .03
tanks, lb.	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb.	.15½- .16	.15½- .16	.15½- .15¾
tanks, lb.	.04½-	.04½-	.05 -
Ammonium carbonate, powd. tech., casks, lb.	.08 - .12	.08 - .12	.08 - .12
Sulphate, wks., cwt.	1.25 -	1.25 -	1.05 -
Amylacetate tech., tanks, lb., gal.	.142-	.14½-	.135-
Antimony Oxide, bbl., lb.	.08½- .09	.08 - .09	.07½- .08
Arsenic, white, powd., bbl., lb.	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs, lb.	.15 - .15½	.15 - .15½	.09 - .10
Barium carbonate, bbl., ton.	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	74.00 -75.00	74.00 -75.00	63.00 -65.00
Nitrate, cask, lb.	.08½- .09	.08½- .09	.07½- .07½
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt.	1.85 - 2.00	1.85 - 2.00	1.75 - 2.00
Borax, grain, bags, ton.	40.00 -45.00	40.00 -45.00	40.00 -45.00
Bromine, cs., lb.	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	3.00 -	3.00 -	2.75 -
Arsenate, dr., lb.	.05 - .07	.05½- .07	.05½- .06½
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton.	17.50 -	17.50 -	17.50 -
flake, dr., wks., ton.	19.50 -	19.50 -	19.50 -
Phosphate, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Carbon bisulphide, drums, lb.	.05½- .06	.05½- .06	.05 - .06
Tetrachloride drums, lb.	.05½- .06	.05½- .06	.05½- .06
Chlorine, liquid, tanks, wks., lb.	.0185-	.0185-	.01½-
Cylinders	.05½- .06	.05½- .06	.05½- .06
Cobalt oxide, cans, lb.	1.35 - 1.40	1.35 - 1.40	1.15 - 1.25
Copperas, bgs., f.o.b. wks., ton.	14.00 -15.00	14.00 -15.00	14.00 -15.00
Copper carbonate, bbl., lb.	.08½- .16	.08½- .16	.07 - .16
Cyanide, tech., bbl., lb.	.39 - .44	.39 - .44	.39 - .44
Sulphate, bbl., cwt.	3.85 - 4.00	3.85 - 4.00	3.50 - 3.75
Cream of tartar, bbl., lb.	.19½- .20	.19½- .20	.14½- .15
Diethylene glycol, dr., lb.	.14 - .16	.14 - .16	.14 - .16
Epsom salt, dom., tech., bbl., cwt	2.10 - 2.15	2.10 - 2.15	1.70 - 2.00
Imp., tech., bags, cwt.	2.00 - 2.10	2.00 - 2.10	1.15 - 1.25
Ethyl acetate, drums, lb.	.08½-	.08½-	.08½-
Formaldehyde, 40%, bbl., lb.	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contract, lb.	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, crude, drums, gal.	.75 -	.75 -	.75 -
Refined, dr., gal.	1.25 - 1.30	1.25 - 1.30	1.25 - 1.30
Glaubers salt, bags, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb	.13½- .14	.12½- .13	.10½- .10¾
Lead:			
White, basic carbonate, dry casks, lb.	.06½-	.06½-	.06½-
White, basic sulphate, sck., lb.	.06 -	.06 -	.06 -
Red, dry, sck., lb.	.06½-	.06½-	.07½-
Lead acetate, white crys., bbl., lb.	.10½- .11	.10½- .11	.10 - .11
Lead arsenate, powd., bbl., lb.	.09 - .13	.09 - .13	.09 - .13
Lime, chem., bulk, ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk, lb.	.05½-	.06½-	.06½-
Lithophone, bags, lb.	.04½- .05	.04½- .05	.04½- .05
Magnesium carb., tech., bags, lb.	.06 - .06½	.06 - .06½	.05½- .06
Methanol, 95%, tanks, gal.	.33 -	.33 -	.33 -
97%, tanks, gal.	.34 -	.34 -	.34 -
Synthetic, tanks, gal.	.35½-	.35½-	.35½-
Nickel salt, double, bbl., lb.	.11½- .12	.11½- .12	.11 - .11½
Orange mineral, csk., lb.	.09½-	.10½-	.10 -
Phosphorus, red, cases, lb.	.45 - .46	.45 - .46	.42 - .44
Yellow, cases, lb.	.28 - .32	.28 - .32	.28 - .32
Potassium bichromate, casks, lb.	.07½- .08½	.07½- .08½	.07½- .08
Carbonate, 80-85%, calc. csk., lb	.07 - .07½	.07 - .07½	.05 - .06
Chlorate, powd., lb.	.09½- .10	.09½- .10	.08 - .08½
Hydroxide (c'stic potash) dr., lb.	.07½- .07½	.07½- .07½	.06½- .06½
Muriate, 80% bgs., ton.	31.90 -	31.90 -	37.15 -
Nitrate, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb.	.18½- .19	.18½- .19	.16 - .16½
Prussiate, yellow, casks, lb.	.18 - .19	.18 - .19	.16½- .17
Sal ammoniac, white, casks, lb.	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt.	1.00 - 1.05	1.00 - 1.05	.90 - .95
Salt cake, bulk, ton.	13.00 -15.00	13.00 -15.00	13.00 -15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 -	1.23 -	1.20 -
Dense, bags, cwt.	1.25 -	1.25 -	1.22½-
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 - 3.00	2.60 - 3.00	2.50 - 2.75
Acetate, works, bbl., lb.	.04½- .05	.04½- .05	.04½- .05
Bicarbonate, bbl., cwt.	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb.	.05½- .06½	.05½- .06½	.044- .05
Bisulphate, bulk, ton.	14.00 -16.00	14.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb.	.03 - .04	.03 - .04	.03½- .04
Chlorate, kegs, lb.	.06½- .06½	.06½- .06½	.05½- .07½
Chloride, tech., ton.	12.00 -14.75	12.00 -14.75	12.00 -14.00
Cyanide, cases, dom., lb.	.15½- .16	.15½- .16	.15½- .16
Fluoride, bbl., lb.	.07½- .08	.07½- .08	.07 - .08
Hyposulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt.	3.25 - 3.40	3.25 - 3.40	3.25 - 3.40
Nitrate, bags, cwt.	1.35 -	1.35 -	1.345-
Nitrite, casks, lb.	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.021- .023	.021- .023	.018- .02
Prussiate, yel. drums, lb.	.11½- .12	.11½- .12	.11½- .12
Silicate (40° dr.) wks. cwt.	.80 - .85	.80 - .85	.70 - .75
Sulphide, fused, 60-62%, dr., lb	.02½- .03½	.02½- .03	.02½- .03
Sulphite, cyrs., bbl., lb.	.02½- .02½	.02½- .02½	.03 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.03½- .04	.03½- .04	.03½- .04
Dioxide, cyl., lb.	.07 - .07½	.07 - .07½	.06½- .07
Flour, bag, cwt.	1.60 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin Oxide, bbl. lb.	.56 -	.58 -	.43 -
Crystals, bbl., lb.	.39 -	.40½-	.33½-
Zinc chloride, gran., bbl., lb.	.05½- .06	.05½- .06	.06½- .06½
Carbonate, bbl., lb.	.09½- .11	.09½- .11	.10½- .11
Cyanide, dr., lb.	.38 - .42	.38 - .42	.38 - .42
Dust, bbl., lb.	.07 - .07½	.07 - .07½	.06½- .07
Zinc oxide, lead free, bag, lb.	.06½-	.06½-	.05½-
5% lead sulphate, bags, lb.	.06½-	.06½-	.05½-
Sulphate, bbl., cwt.	3.00 - 3.25	3.00 - 3.25	3.00 - 3.25

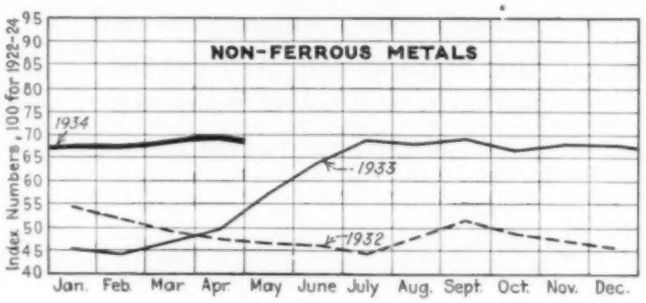
Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.09½-$0.10	$0.09½-$0.10	$0.08½-$0.09
Chinawood oil, bbl., lb.	.09½-	.08½-	.06½-
Coconut oil, Ceylon, tanks, N. Y. lb.	.02½-	.02½-	.03½-
Corn oil crude, tanks, (f.o.b. mill), lb	.04½-	.04½-	.04½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.04½-	.04½-	.04½-
Linseed oil, raw car lots, bbl., lb.	.099-	.093-	.09 -
Palm, Lagos, casks, lb.	.03½-	.03½-	.04½-
Palm Kernel, bbl., lb.	.03½-	.04½-	.04½-
Peanut oil, crude, tanks (mill), lb.	.05½-	.05½-	.04½-
Rapeseed oil, refined, bbl., gal.	.38 - .40	.39 - .41	.49 - .50
Soya bean, tank, lb.	.06 -	.06½-	
Sulphur (olive foots), bbl., lb.	.07½-	.07 -	.05½-
Cod, Newfoundland, bbl., gal.	nom.	nom.	.24 - .25
Menhaden, light pressed, bbl., lb.	.051-	.051-	.047-
Crude, tanks (f.o.b. factory), gal.	.20 -	.20 -	.15 -
Grease, yellow, loose, lb.	.03½-	.03½-	.03½-
Oleo stearine, lb.	.05½-	.05½-	.05 -
Red oil, distilled, d.p. bbl., lb.	.07 -	.07 -	.06½-
Tallow, extra, loose, lb.	.03½-	.03½-	.03½-









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Bensol, 90% tanks, works, gal.	.19 - .20	.19 - .20	.22 - .23
Beta-naphthol, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U. S. P., dr., lb.	.11 - .11½	.11 - .11½	.10½- .11
Cresylic acid, 97%, dr., wks., gal.	.50 - .51	.50 - .51	.42 - .45
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl. lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil 25% dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.	.06 - .07	.06 - .07	.04½- .05
Nitrobenzene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.	.14½- .15	.14½- .15	.14½- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal.	1.10 - 1.15	1.10 - 1.15	.90 - .95
Resorcinal, tech., kegs, lb.	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.	.40 - .42	.40 - .42	.40 - .42
Solvent naphtha, w.w., tanks, gal.	.26 -.....	.26 -.....	.26 -.....
Tolidine, bbl., lb.	.88 - .90	.88 - .90	.88 - .90
Toluene, tanks, works, gal.	.30 -.....	.30 -.....	.30 -.....
Xylene, com., tanks, gal.	.26 -.....	.26 -.....	.26 -.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb.	.12½- .13	.12 - .13	.10½- .11½
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 - .20	.04 - .20	.02½- .20
Prussian blue, bbl., lb.	.35½- .37	.35½- .37	.35 - .36
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.06 - .32
Chrome green, bbl., lb.	.26 - .27	.26 - .27	.27 - .30
Carmine red, tins, lb.	4.00 - 4.40	4.00 - 4.40	3.90 - 4.50
Para toner, lb.	.80 - .85	.80 - .85	.75 - .80
Vermilion, English, bbl., lb.	1.58 - 1.60	1.60 - 1.63	1.10 - 1.30
Chrome yellow, C. P., bbl., lb.	.15 - .16	.15 - .15½	.15 - .15½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb.	.09 - .10	.08 - .09	.06 - .08
Manila, bags, lb.	.09 - .10	.09 - .10	.16 - .17
Damar, Batavia, cases, lb.	.15½- .16	.15½- .16	.16 - .16½
Kauri No. 1 cases, lb.	.20 - .25	.20 - .25	.45 - .48
Kieselguhr (f.o.b. N.Y.), ton.	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -.....	50.00 -.....	40.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.75 -.....	6.05 -.....	4.75 -.....
Turpentine, gal.	.52 -.....	.56 -.....	.47 -.....
Shellac, orange, fine, bags, lb.	.37 -.....	.35 - .36	.19 - .20
Bleached, bonedry, bags, lb.	.35 - .36	.35 - .36	.20 - .21
T. N. bags, lb.	.28 - .29	.28 - .29	.11½- .12
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 -.....	13.75 -.....	13.75 -.....

INDUSTRIAL NOTES

THE FOSTER WHEELER CORP., New York, has taken over exclusive rights for the sale and manufacture of the Ruths steam storage systems in the United States and Canada. Ruths Accumulators will compliment the present line of Foster Wheeler power plant equipment. G. M. Cameron, formerly manager of Ruths Steam Storage Co., will be manager of the accumulator division.

THE DORR-OLIVER CORP., New York, has been dissolved and The Dorr Co., Inc. and the Oliver United Filters, Inc. will operate independently of each other. Oliver United will, however, undertake the further adaptation and marketing of the Dorrco Filter in the United States and in certain other countries; and Oliver United products, including filters, will be handled in European territories by the foreign representatives of The Dorr Co.

UNITED STATES STONEWARE CO., New York, has moved its factory office from Akron, Ohio to Tallmadge where a new two-story administration building has just been completed.

GENERAL REFRACTORIES CO., Philadelphia, has appointed John C. Hopkins district sales manager of the Cleveland office.

REPUBLIC STEEL CORP., Youngstown, Ohio has appointed Railey & Milam, Inc., Miami, Fla., as distributors of Enduro stainless steel and Toncan iron. The Ohio Valley Hardware & Roofing Co., Evansville, Ind., also will distribute Toncan iron.

COMBUSTION ENGINEERING CO., INC., New York, has made H. S. Colby, formerly president of the Air Preheater Corp., general sales manager.

PATTERSON FOUNDRY & MACHINE CO., East Liverpool, Ohio, announces the appointment of William Soherr as manager of their New England territory.

NATIONAL ENGINEERING CO., Chicago, has conferred the title of vice-president and sales manager upon L. B. Knight, Jr. A. C. Christensen has been made vice-president and chief engineer.

UNIVERSAL OIL PRODUCTS CO., owner of the Dubbs cracking process has moved its New York office to 50 West 50th St.

THE ANGLO-AMERICAN CHEMICAL CORP., Philadelphia, has taken over the manufacture and sale of certain chemical products formerly sold by the American Chemical Products Co., Rochester, N. Y. These chemical bases when blended with mineral oil or grease convert these oils into products of high load carrying capacity, known as extreme pressure lubricants.

HERCULES POWDER CO., Wilmington, has opened an office in the Fidelity-Philadelphia building, Philadelphia, for the sale of wood rosin and turpentine. C. H. Boys will manage the office.

NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative to Date	
	Proposed Work and Bids	Contracts Awarded	Proposed Work and Bids	Contracts Awarded
New England	$88,000	.....	$975,000	$590,000
Middle Atlantic	505,000	$538,000	2,599,000	2,182,000
Southern	.....	110,000	11,567,000	1,405,000
Middle West	228,000	145,000	2,782,000	1,753,000
West of Mississippi	236,000	255,000	14,649,000	361,000
Far West	29,000	209,000	1,662,000	913,000
Canada	175,000	30,000	2,366,000	.....
Total	$1,261,000	$1,287,000	$36,600,000	$7,204,000

PROPOSED WORK
BIDS ASKED

Brass Factory—Bridgeport Brass Co., East Main St., Bridgeport, Conn., contemplates the construction of a 1 story, 55x130 ft. factory. Fletcher-Thompson, Inc., 1336 Fairfield Ave., Bridgeport, are architects. Estimated cost to exceed $28,500.

Brick Plant — Harris County Brick Co., Houston, Tex., had plans prepared by E. H. Stubee, Archt. & Engr., Houston, for 2 story brick manufacturing plant on Liberty Rd. Estimated cost $150,000.

Brick Plant — Raymond-Newhall-Ried, Inc., Aurora, Ill., contemplates the construction of a brick manufacturing plant. Estimated cost $30,000.

Cork Factory—United Cork Co., Grant Ave., Lyndhurst, N. J., plans to repair its factory recently damaged by fire. Estimated cost exceeds $28,000.

Chemical Factory — Marley Freres, Ltd., Kitchener, Ont., Can., manufacturer of chemicals, cosmetics, etc., contemplates the construction of a plant. Estimated cost $25,000.

Chemical Factory — The Upjohn Co., Kalamazoo, Mich., is having prelimnary plans prepared by Albert Kahn, Archt., New Center Bldg., Detroit, Mich., for the construction of a 10 story chemical factory.

Distillery—Haddam Distillers, Moodus, Conn., are having plans prepared by A. P. Hill Associates, c/o Owners, for the construction of a rye distillery. Estimated cost exceeds $30,000.

Distillery — McCormick Mercantile & Distillery Co., Waldron, Mo., S. McCormick, Pres., plans the construction of a 2 story distillery. Estimated cost exceeds $30,000.

Distillery — Mimbres Valley Distillery Co., Deming, N. M., plans the construction of a 40x100 ft. distillery and will be in the market for new machinery.

Distillery—Old Orchard Distillery, Elverson, Pa., is having plans prepared by Edwards & Hoffman, Philadelphia, Pa., for altering distillery, including new still room and equipment. Estimated cost $28,000.

Distillery — Susquehanna Distillery, Athens, Pa., C. E. Miller, Pres., plans to alter and recondition distillery at Interstate Fair Grounds. Estimated cost exceeds $30,000.

Distillery — Uniontown Distilling Syndicate, Uniontown, Pa., M. E. Minert, plans to recondition distillery here. Estimated cost exceeds $30,000.

Glass Factory — Eclipse Glass Co., c/o H. Otto Vogt, Thomaston, Conn., plans to alter and construct brick addition to factory on North Main St. Carl V. Johnson, Newfield Rd., Torrington, is architect. Estimated cost $28,500.

Laboratory—Arkansas Highway Dept., Little Rock, Ark., will construct a 2 story testing laboratory at 6th and Marshall Sts., Little Rock. W. W. Zass is engineer.

Laboratory — University of Michigan, Ann Arbor, Mich., plans to construct an addition to its engineering laboratory. Estimated cost $28,000.

Laboratory and Medical Clinic — M. H. Koumrian, M.D., 85-45 118th St., Richmond Hill, L. I., N. Y., will soon award the contract for a 3 story, 60x65 ft. laboratory and medical clinic.

Laboratory—School District of Reading, 8th and Washington Sts., Reading, Pa., plans the construction of a new high school, including laboratories, at Front and Spring Sts. Associated Architects, 147 North 5th St., Reading, are architects. Total estimated cost $1,500,000.

Oil Refinery—Franklin Creek Refinery, Carl H. Alsberg, Mgr., Franklin, Pa., plans to improve its refinery, including new fractioning tower, lube rerun column and Fullers earth burner unit. Estimated cost $200,000.

Oil Refinery — Petroleum Engineering Co., Ltd., Winnipeg, Man., plans the construction of an oil refinery. Estimated cost $100,000.

Oil Refinery—Rio Grande Oil Co., 417 South Hill St., Los Angeles, Calif., plans the construction of a new refining plant in the eastern portion of South Gate, Calif. Estimated cost $28,500.

Paper Mill — Clifton Paper Mills, Clifton, N. J., plans to repair the damage recently done by fire at its mills on Ackerman Ave. Estimated cost $30,000.

Paper Mill—Mead Paper Co., Menasha, Wis., contemplates altering and building an addition to its mill. Estimated cost $30,000.

Powder Factory—Gold Dust Corp., 5300 Holabird Ave., Baltimore, Md., manufacturer of washing powder, etc., will soon award the contract for a 55x75 ft. addition to its kettle house and alterations to its boiler house. Lockwood, Greene Engineers, Inc., 30 Rockefeller Plaza, New York, are engineers.

Powder Blending Tower—E. I. duPont de Nemours Co., Carneys Point, N. J., and Wilmington, Del., is having plans prepared by its Engineering Department for alterations and repairs to its powder blending tower at Carneys Point. Estimated cost including equipment $28,000.

Powder Factory—Premier Bronze Powder Co., Painesville, O., G. F. Glass, Pres., contemplates rebuilding its factory recently destroyed by fire. Estimated cost exceeds $40,000.

Radio Tube Factory — Johnsonburg Radio Corp., Johnsonburg, Pa., manufacturer of radio tubes, contemplates the construction of a 2 story addition to its plant, also the installation of new machinery and equipment. Estimated cost $75,000.

Rubber Factory—Trafalgar Rubber Co. Ltd., Cooksville, Que., is having plans prepared for the construction of a factory. Estimated cost $50,000.

CONTRACTS AWARDED

Chemistry Building—Washington State College, Pullman, Wash., awarded contract for 4 story chemistry building to A. F. Mowatt, McDowell Bldg., Seattle. Estimated cost $163,650.

Distillery — Buffalo Springs Distilling Co., Buffalo Springs, Ky., is constructing a distillery by day labor. Project includes still building and stills, warehouses, etc. Estimated cost $110,000.

Distillery—Holly Hills Distillery, Holly Hills, Mich., had plans prepared by G. A. Bachman, Archt. and Engr., Flint, Mich., for a distillery. Separate contracts have been awarded for the work. Estimated cost exceeds $30,000.

Distillery — Trenton Valley Distilling Co., Trenton, Mich., awarded contract for distillery to Culbertson & Kelly, 872 West Milwaukee Ave., Detroit. Estimated cost $40,000.

Glass Factory—Hazel-Atlas Glass Co., 89th Ave. and G St., Oakland, Calif., awarded contract for addition to glass plant to Larsen & Larsen, 629 Bryant St., San Francisco. Cost exclusive of equipment $25,000.

Laboratory—Rensselaer Polytechnic Institute, Troy, N. Y., awarded contract for 5 story, 60x185 ft. laboratory to W. L. Crowe Construction Co., 101 Park Ave., New York, N. Y. Estimated cost $300,000.

Paper Plant — Northern Paper Mills, G. Gochnauer, Supt. of Constr., Green Bay, Wis., is building a 1 story, 95x241 ft., warehouse at its plant by day labor.

Pottery Plant — Mt. Clemens Pottery, Mt. Clemens, Mich., awarded contract for pottery plant, to the Austin Co., 2248 General Motors Bldg., Detroit. Estimated cost $40,000.

Process Plant — New Process Co., Warren, Pa., awarded contract for rebuilding factory and warehouse destroyed by fire, to Lakeland Engineering & Construction Co., Electric Bldg., Buffalo, N. Y. Estimated cost $150,000.

Refinery—Corpus Christi Refining Co., Corpus Christi, Tex., plans to construct a unit at its plant for the manufacture of gasoline and concentrates. Work will probably be done by day labor. Estimated cost $75,000.

Refinery—Corporation, c/o R. C. Andre, Lincoln and Cumberland Highways, Evanston, Wyo., will build an oil refinery. Separate contracts have been awarded for the work. Estimated cost $30,000.

Oil and Gas Development—Empire State Refining Corp., Bolivar, N. Y. F. R. Beckwith, Pres., is enlarging its oil and gas development here, including pipe line, pumping plant and refinery, by day labor and separate contracts. Estimated cost $30,000.

Lubricating Plant—Penant Oil & Grease Co., Santa Fe Ave., Los Angeles, Calif., awarded contract for an oil storage terminal at Parr Terminal, Richmond, Calif., to P. M. Sanford, P. O. Box 1961, Richmond. Cost exclusive of equipment $20,000.

Gasoline Plant — Shell Petroleum Corp., Houston, Tex., awarded contract for natural gasoline plant, including compressor, distilling unit, pump buildings, etc., to Stern Rogers Co., Denver, Colo. Estimated cost $150,000.

Roofing Plant—Tilo Roofing Co., 370 Lexington Ave., New York, N. Y., awarded contract for altering and building brick addition to plant at Stratford, Conn., to Michaels & Co., Meriden, Conn. Estimated cost $30,000.

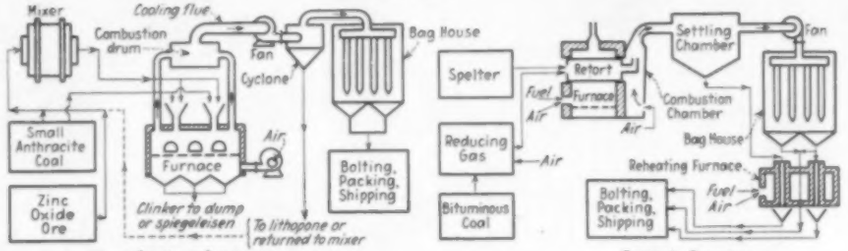
Rubber Factory—Ideal Rubber Co., 53 Third Ave., Ottawa, Ont., Can., R. J. Reaney, Pres., has awarded the contract for the first unit of its factory near Eastview to F. H. Guick, Eastview, Ont. Estimated cost $30,000.

Varnish Plant—Harlip Realty Corp., 43-15 36th St., Long Island City, N. Y., will build a plant to be leased to the Harlip Shellac & Varnish Co., same address. General and separate contracts are now being awarded for the work.

CHEM. & MET. FLOW SHEETS OF PROCESS INDUSTRIES

Continued from Supplement to May, 1934, *Chem. & Met.*

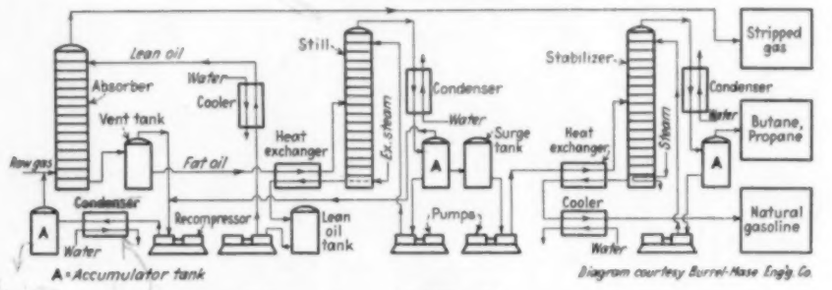
ZINC OXIDE



American (Wetherill) Process — French Process

			To produce 1 ton ZnO (total, all grades)		
Zinc Oxide Ore (50% Zn)	1.9 tons			Spelter	1740 lb.
Coal	3-5 tons			Coal	1390 lb.
Electricity	360 kw-hr.			Electricity	35 kw-hr.
Direct labor	8 man-hr.			Direct labor	5 man-hr.

NATURAL GASOLINE



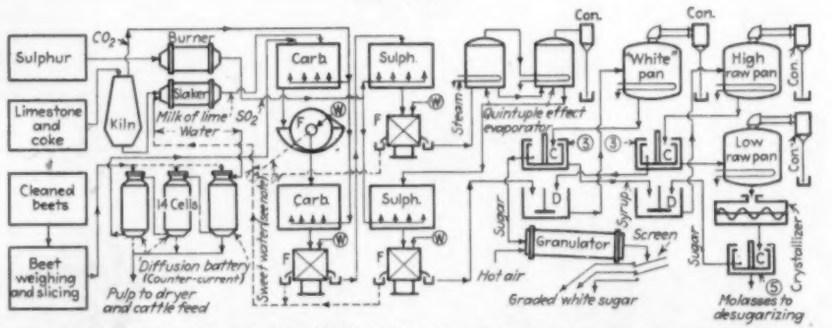
A = Accumulator tank

Diagram courtesy Burrel-Hasse Engg. Co.

Natural gas (150-lb. pressure)	20,000,000 cu. ft.	Per 24-hr. day, producing 10,000 gal. gasoline
Absorption oil recirculation per day	150,000 gal.*	
Steam	60,000 lb.	
Water	200,000 gal.	
Electricity	20 kw-hr.	
Direct labor	42 man-hr.	

*Loss approx. 6 gal. per 1,000 gal. gasoline produced (Dykema & Chenoweth, Bur. Mines Tech. Paper No. 263).

BEET SUGAR

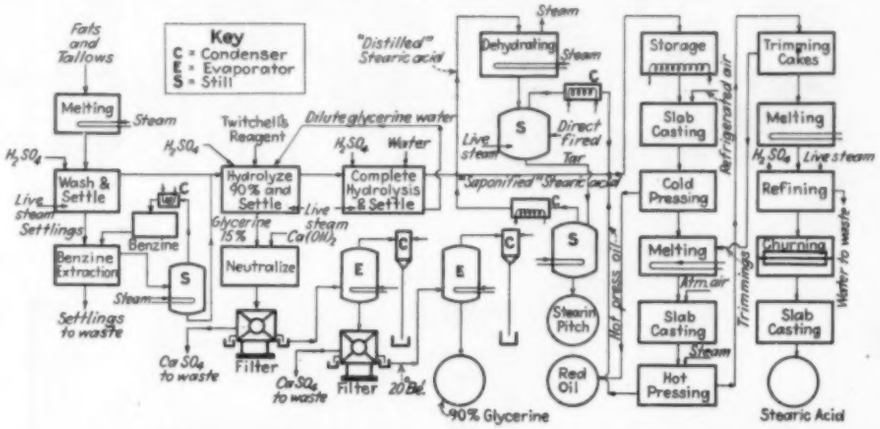


Key: Carb., carbonators; Sulph., sulphitors; F., filters; W, wash water; C., centrifugals; Con., condensers; D., dissolvers

Note: About half of all plants use sweet water from filter washing for slaking lime; others use fresh water

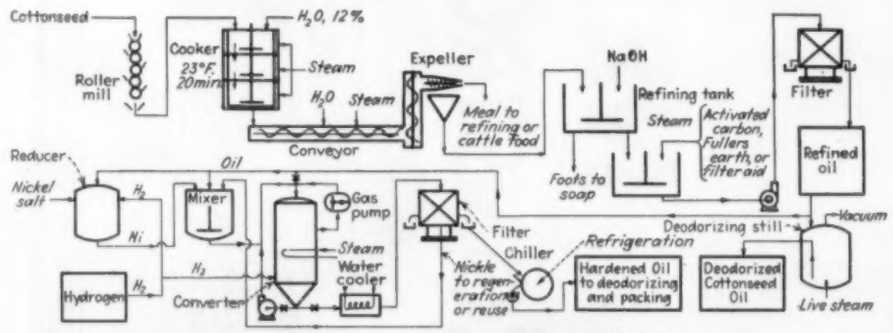
				To Produce
Farm land	0.6 acre	Coal (power and heating)	1.0 ton	1 ton refined sugar
Sugar beets	8.0 tons	Sulphur	10 lb.	800 lb. molasses (50 per cent sucrose)
Limestone	0.5 ton	Water	90 tons	800 lb. dried pulp
Coke	0.05 ton	Direct labor	16-20 man-hr.	

STEARIC ACID AND RED OIL



				To Produce
Fats and tallows	6,600 lb.	Steam	18,000 lb.	1 ton double-pressed, distilled stearic acid, plus 2 tons red oil and 600 lb. crude glycerine
Sulphuric acid (60° Be.)	600 lb.	Refrigeration	3 tons	
Twitchell's reagent	120 lb.	Electricity	10 Kw.-hr.	
Hydrated lime	20 lb.	Direct labor	50 man-hr.	
Benzine (loss)	2 lb.			

COTTONSEED OIL HYDROGENATION



Refined and Deodorized Oil

Cottonseed	55 lb.	Per gallon oil
NaOH	0.1 lb.	
Water (cooling)	20 gal.	
Steam	15 lb.	
Direct labor	0.015 man hr.	

Hydrogenerated Oil

Refined cottonseed oil	0.134 gal.	Per pound hardened oil
Nickel	0.00075 lb.	
Hydrogen	0.75 cu. ft.	
Water (cooling)	0.6 gal.	
Steam	0.5 lb.	
Electricity (including electrolysis)	0.1 kw-hr.	
Direct labor	0.0006 man hr.	

Note: *This flow sheet combines processes not ordinarily performed in the same plant. The first processor may produce crude oil, for example, while a second will refine and hydrogenate it. Oils hydrogenated for food are deodorized after hardening.*